The Welding Engineer

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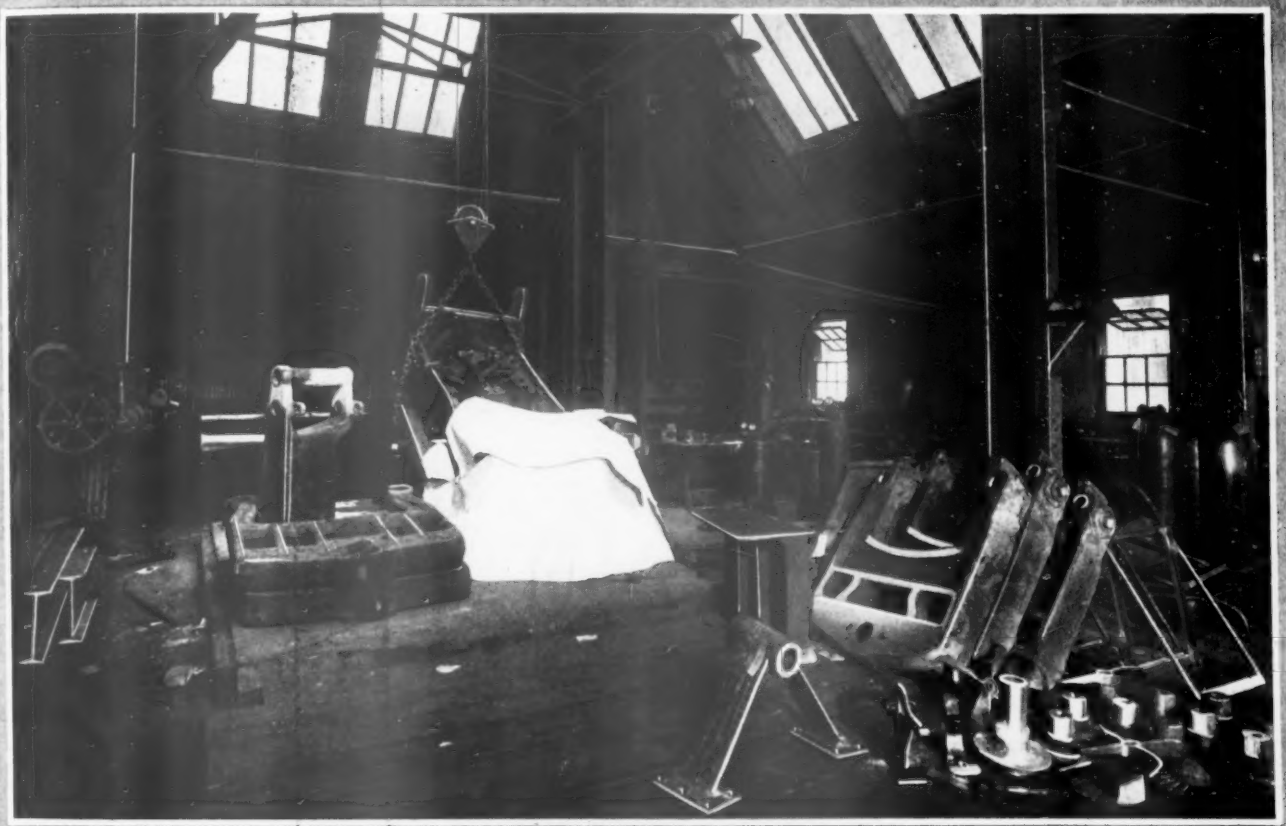

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Messer Mfg. Co.
Welding Supply Co.
K-G Welding & Cutting Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
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Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

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Burdett Oxygen Co.
Davis-Bournonville Co.
The Harris Calorific Co.
Messer Mfg. Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.

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Burdett Oxygen Co.
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Messer & Co.
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Henderson-Willis Welding & Cutting Co.
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Oxweld Acetylene Co.
Page Steel & Wire Co.
Steel Sales Corp.
Torchweld Equipment Co.

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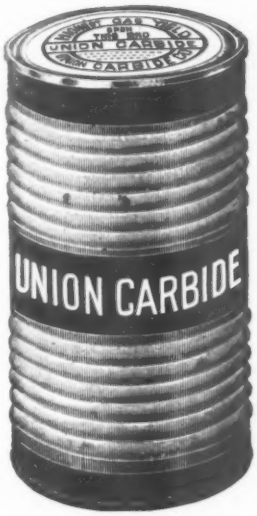

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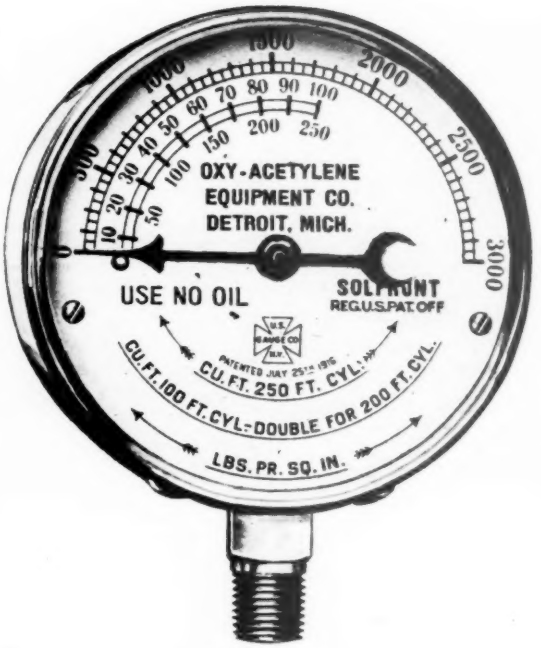

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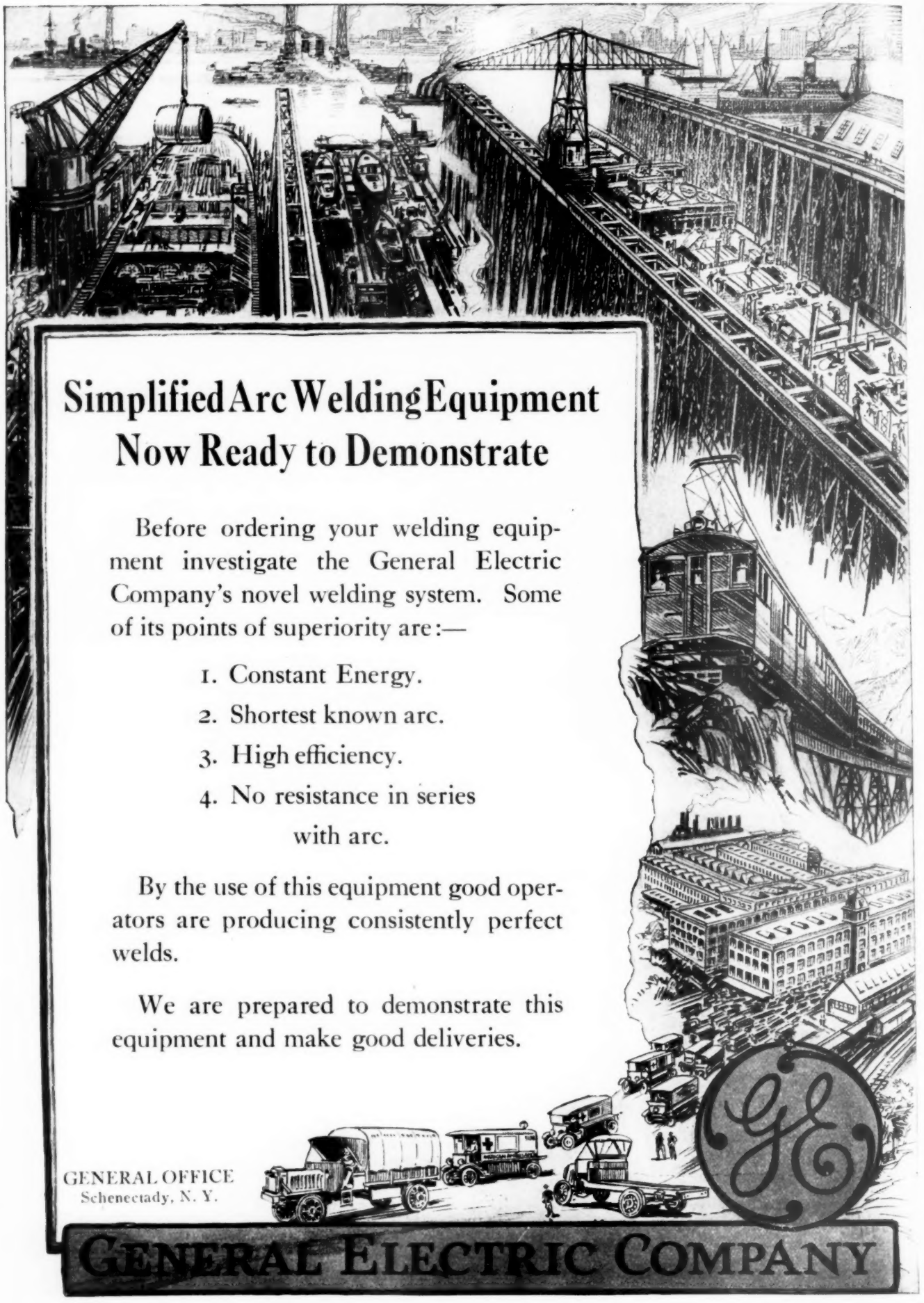

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The REGO No. 10 tip requires less than 9 pounds oxygen pressure.

A prominent medium pressure type torch requires for the same size 24 pounds oxygen pressure.

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The **REGO** principle materially saves oxygen; no more oxygen can come through the flame than is just necessary to support combustion.

This principle insures a flame truly neutral—a steel weld is made with less oxidation than with a flame produced with oxygen under high pressure.

It eliminates the flashback. The **REGO** simply doesn't flash—it **cannot** flash.

Technical principles may be difficult to understand by **reading** about them. The **use** of **REGO** apparatus convinces quickly and positively.

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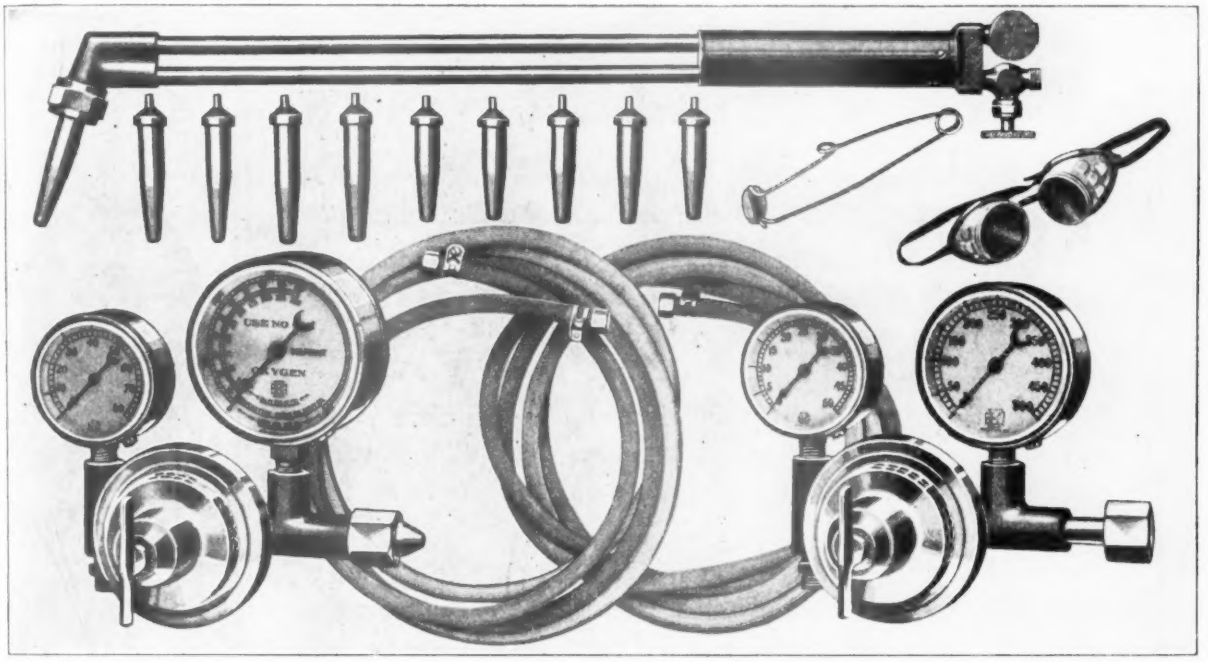

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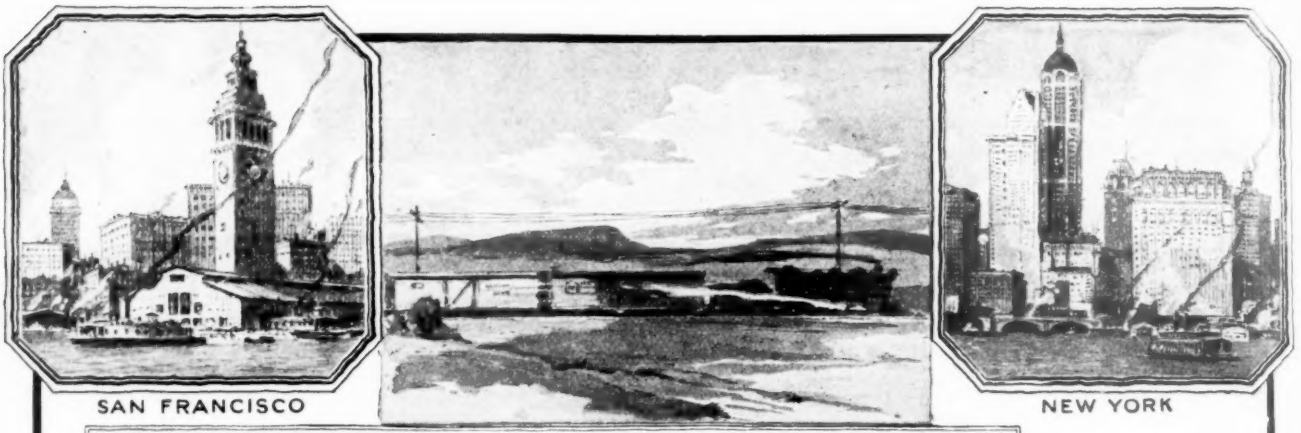

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42nd Street Bldg., New York City

AUTOMOBILE WELDING

By M. Keith Dunham

Chapter X—Oxygen Supply—Care of Oxygen Cylinder—Acetylene Generator—Care of Generator—Regulators—Care of Regulators—Creeping Regulators—Gauges—Care of Gauges—Welding Torch—Care of Welding Torch—Effects of Heat—Hose and Goggles

A workman in any line must have a knowledge of the tools he uses. The operator of the oxy-acetylene flame must understand the principles of his apparatus to avoid serious errors. Knowledge of the gases used, as well as an understanding of the regulators, torch, supplies and shop equipment, is essential to an intelligent application of the flame.

Oxygen Supply.—Tank oxygen is today in universal use by oxy-acetylene shops. There is no method of producing it on any small scale which will compete in cost with it. When we specify tank oxygen, we mean that purchased in seamless drawn cylinders under a pressure of 1,800 pounds to the square inch.

The oxygen purchased in this form is produced by two different methods—one by electrical decomposition of water, which consists of two parts of hydrogen and one of oxygen. By this method, which is termed the electrolytic process, the water is decomposed into its constituents and the oxygen after being led into a gasometer is from there pumped into a steel cylinder under pressure. The other process is known as the liquefaction system. The air, which consists of four parts nitrogen and one part oxygen, is frozen. When the air reaches this liquid condition, the nitrogen boils off first, leaving the oxygen, exactly the same as if gasoline and oil were mixed together and placed in an open vessel, the gasoline would first evaporate. The oxygen is then led to the gasometer and from there pumped into a steel cylinder ready for shipment.

Both methods produce a commercially pure oxygen with practically no difference between them for welding purposes.

Care of Oxygen Cylinder.—Oxygen is a non-combustible element. It will not burn, but it is the supporter of combustion—without it nothing will burn. Obviously, some care must be used, since its escape from the cylinder in the vicinity of sparks, a flame or any greasy or oily substances, may be hazardous.

Oxygen is usually supplied in a cylinder with a narrow base which is easily tipped over unless some precautions are used to guard against this. If a truck is employed, the tank is chained or strapped to the truck. If the cylinder is used without a truck it should never be left standing without support, but should be clamped to the wall or the bench, and where this is not possible it should be placed in a horizontal position on the floor. Regulators are sometimes destroyed by the oxygen cylinder being tipped over and care should be taken to prevent this.

Since oxygen is the supporter of combustion, particular caution must be exercised not to oil or grease any part of the oxygen supply line, particularly the outlet of the oxygen tank valve or the oxygen regulator. If any grease is present with oxygen under a high pressure there is an ideal condition for spontaneous combustion and a violent explosion may result.

Due sometimes to natural conditions, but at others to carelessness, considerable water may be present in the cylinder. This water will damage the regulator and as well adversely affect the welding flame. At intervals it is advisable to test cylinders by tipping them upside down and opening the valve slightly to detect the presence of any considerable volume of water. This method will expel the water from the cylinder before the regulator is attached.

As a general rule, repairs to the oxygen cylinder valve should not be attempted by the user, but the cylinder, if in a leaky condition, should be returned to the manufacturer for repair.

Acetylene Generation.—Acetylene gas is produced by allowing carbide to come into contact with water. The process of manufacture is so very simple that apparatus not meeting the requirements of safe and pure generation has been common. Lately, however, these poor generators have been very much in the minority and very few are not sold. A generator which will deliver reasonably pure gas safely must be built with the following requirements:

A capacity of one gallon of water for each pound of carbide; means to prevent a pressure greater than 15 pounds to the square inch; automatic control of feed mechanism; water valve to prevent return of flame into the generator; filtering or screening devices to prevent dust or dirt getting into the flame.

These are but a few of the proper requirements of a good generator. The National Board of Fire Underwriters' rules specify in detail how the generator shall be constructed. It is hardly necessary to add that any user should see that his generator is built in accordance with these specifications.

Care of Generator.—One of the important things to guard against in the use of the generator is the excessive use of gas. If it is generated too quickly, there is undue heating of the gas, and when acetylene reaches a critical point of temperature it ceases to be acetylene, but is a mixture of gases. It will burn, but it gives an improper flame—one wholly unsuitable for steel welding particularly.

The generator should not be called upon at any time to deliver more than one foot per pound of carbide per hour. This, if it is a carbide to water feed; if water to carbide, half this speed. That is, a generator with a 50-pound capacity of carbide should not be used at a rate greater than 50 cubic feet per hour. Particular care should be used in recharging the generator, to thoroughly wash out all the residue and to follow minutely the instructions of the manufacturer in its care.

There is a custom at times among users not familiar with the peculiarities of acetylene gas under pressure to lock the safety device. Such a proceeding is criminally careless and may lead to loss of life.

Dissolved Acetylene.—Dissolved acetylene, or as it is more commony called tank acetylene, is in wide use by all classes of users. Here gas is bought in ready-made form, ready for use by the opening of a valve. Care is exercised by the manufacturer of dissolved acetylene to purify it before it is compressed into the cylinder. These cylinders vary in size according to the needs of the user, from 100 cubic feet capacity to 500 cubic feet capacity.

Since acetylene is dangerous under pressure in a free state, the method of eliminating this hazard is interesting. The cylinder is filled with a porous material and then acetone, a very volatile liquid, is poured into the cylinder. This acetone ab-

sorbs the acetylene and as there is no free space in the tank there is no danger in handling or using acetylene furnished in this way.

Care of Acetylene Cylinder.—Since the acetylene gas is dissolved in acetone it should not be withdrawn from the tank at a rate fast enough to bring out with it this liquid, which is harmful in its effects on molten metal. The flame used should not require an acetylene consumption at a rate greater than one-seventh the capacity of the tank per hour, that is, a 100-foot cylinder should last seven hours.

It is for this reason that steel welds made with acetylene from an automobile lighting cylinder are so often unsatisfactory. The gas in automobile cylinders costs more than that in regular size welding tanks and except in emergencies the automobile cylinder should not be used. If it is necessary to employ these cylinders instead of welding cylinders, it is advisable to connect three or four on a manifold to eliminate the possibility of the withdrawal of the acetone.

Acetylene cylinders, when full, should be kept away from any excessively hot place, since the pressure in the cylinder will double as the temperature is doubled.

When the cylinder is exhausted of its gas the valve should be closed, for it must be remembered that the tank still contains acetone which will evaporate with the valve open and it will do this especially quick if the cylinder is in a warm place.

Leaks are quickly detected, as acetylene had a decided odor. It is hardly necessary to state that these leaks should be hunted for with soap suds and not with a match.

Regulators.—An essential part of the welding equipment is the regulator. Successful welding demands that the two gases be delivered to the torch in unvarying proportions and it is the duty of the regulator to reduce the pressure of the gases in the cylinder to the desired using pressure. In principle, all regulators are alike. A diaphragm is interposed between the cylinder pressure and a spring, and when the pressure in the body of the regulator exceeds the tension of the spring, the diaphragm is pushed outward, overcoming the spring tension. Attached to the diaphragm is a seat or plunger, varying in design with the different types, which closes the inlet from the cylinder, as the spring tension is so overcome.

The details will of course vary—in some instances the diaphragm is metal; in others, a rubber composition. At times, the action of the seat, in conjunction with the diaphragm, is direct; at others, it may be compounded. Some regulators are equipped with diaphragm safety devices to permit the escape of gas if for any reason the seat does not properly close. Others do not have this safety. The manufacture of a proper regulator is no easy task and undoubtedly there are poorly constructed one in use. But even a good regulator will not long remain in good working order unless it is cared for properly, and the user cannot give it this care unless he understands its principle.

Care of Regulator.—In Fig. 4 is illustrated one type of regulator which is in wide use. The regulating screw pushes against two springs, one within the other, the object in this instance being to secure flexibility by having a comparatively light spring take care of the pressure up to about five pounds and the heavy, outer springs actuate from five pounds up. As the springs press against the diaphragm, the seat, which is attached to the diaphragm by means of a yoke, is pushed away from the inlet nozzle. As the spring tension is released the seat closes against the nozzle; or when the regulator is in use the pressure of the gas entering the regulator will close the seat when it becomes greater than the spring tension.

It will be seen that the diaphragm is constantly moving, and that therefore the seat is subjected to considerable wear by being brought into contact many times with the inlet nozzle. The user must see that this movement of the dipahragm is never sudden; otherwise, the seat is liable to be quickly destroyed.

A very frequent cause of regulator trouble is due to the operator turning on the pressure by opening the valve of the gas cylinder while there is tension on the springs. Since we have learned that while the spring tension is on the diaphragm, the seat is away from the inlet nozzle, it can be appreciated that the sudden entrance of the gas will cause the seat to be thrown against the inlet nozzle with considerable violence.

One rule, then, which should always be followed: Have the spring tension released (thumb screw unscrewed) when turning on the gas.

Another way of quickly destroying the seat is to reduce from higher to a lower pressure with the outlet closed. To illustrate, assume that the torch is being operated with a large tip requiring an oxygen pressure of, say, forty pounds. The tip on the welding torch is changed to a small one requiring a pressure of one or two pounds and the thumb screw then unscrewed (tension of springs released) and the valve of the welding torch then opened. There being little or no tension against the diaphragm, it is suddenly forced outward and the seat again brought violently against the inlet nozzle. This abuse is likely also to buckle the diaphragm, so that still another rule to remember in handling the regulator is: Always reduce from a higher to a lower pressure with the outlet open.

Creeping Regulators.—A regulator "creeps" when the seat does not close against the inlet nozzle, allowing the gas from the cylinder to enter the body of the regulator beyond the pressure desired. A creeping regulator is detected by the low pressure gauge, the one over the body of the regulator, the dial of which is calibrated in pounds up to fifty or seventy-five. With the valves on the torch closed, the hand on the dial does not remain stationary, but indicates a higher pressure than it did while operating the torch. A creep of a few pounds is allowable, but when it is ten or fifteen or twenty pounds beyond the operating pressure, the use of the regulator becomes a menace, since the pressure may become great enough in the body of the regulator to burst the diaphragm or the gauge with considerable force, if there is no safety of an approved design.

The user then should become acquainted with his regulator and be able to renew the seat when required. In the type illustrated the back cap, which is in the form of a square nut, may be screwed off, exposing three screws which hold the seat retainer to the yoke. After these screws are taken out, the seat may be examined and if in bad condition it may be turned over and the other side used; or if both sides are in poor shape, a new seat may be put in.

Particular care should be exercised that this seat be correct. Any material handy must not be used since there are very few substances suitable. It is advisable to secure from the manufacturer extra seats when the regulators are purchased and have them on hand. For reasons already explained, see that no grease or oil gets into the interior of the regulator. Some little judgment is necessary in adjusting the regulator, after inserting a new seat, and it is sometimes necessary (in the type illustrated) to bring the seat closer to the inlet nozzle by putting a small piece of paper in back of the seat. In other types it is only necessary to screw the seat closer to the nozzle, but with all, the idea is to have the seat in contact with the nozzle with the spring tension relieved; then with the gas from the cylinder turned on, no gas should come through the regulator until some tension is put on the springs.

Considerable space has been devoted to the regulator, since it is a common practice to pay no attention to the action of it. Not only is good welding difficult with a regulator out of order, but there is a danger hazard not to be passed over lightly. A good mechanic understands his tools—see, then, that we understand the regulator.

Gauges.—Both the oxygen and acetylene regulators, if we use the tank system of acetylene, should be equipped with two gauges each, one indicating the pressure in the cylinder and the other the using pressure. Some of the lower price apparatus are sold without these tank indicating gauges and while the regulator may be, and probably is, of good construction, the user is handicapped without them, since he cannot at any time estimate the cost of the job being done or tell the contents of the cylinder.

The dial of the high pressure oxygen gauge is sometimes calibrated in atmospheres and sometimes in pounds, and recently there has been a tendency to use both calibrations on the same dial and as well a percentage graduation. This is sometimes confusing to the user.

While the cubic capacities of the cylinders vary, some being of 50, others of 100, 150, or 200 feet, the initial pressure is always the same—120 atmospheres. For all practical purposes, we may consider one atmosphere equal to 15 pounds, so that a full cylinder will register on the high pressure gauge 120 atmospheres of 1,800 pounds or 100 per cent. Knowing the size of the cylinder, it is very easy to figure how much gas is used or how much is left in the cylinder.

The tank pressure indicating gauge on the cylinder of acetylene does not indicate the contents of the cylinder, as it does with oxygen. As we have already learned, acetylene is dissolved in a liquid and there is no method of determining the contents of the acetylene cylinder by gauge pressure—this gauge is merely a help in estimating the contents. In later chapters, we will take up the method of ascertaining costs.

Care of Gauges.—At all times care should be used not to break the glass of the gauge, and if broken, it should be promptly replaced. Remember that the low pressure gauge on each regulator is the index of regulator trouble—it warns us of the need of repairing the regulator. It is the danger signal of the welding apparatus and should always be in good working order.

Welding Torch.—There are as many different types of welding torches as there are kinds of automobiles. Some use the acetylene under a very low pressure; these we call injector torches. Others use the acetylene under a pressure up to eight or ten pounds and are termed medium pressure torches. In both designs, the oxygen is used under a considerably higher pressure than the acetylene. And finally, there is the equal pressure torch, using both gases under about the same pressure. It is not our purpose to discuss the relative claims of the exponents of the various classifications. Mechanically, the welding torch which is to be used for repair purposes should be rigidly constructed, since it is subjected to considerable variation in temperature. A torch which is built from very light material may be exactly right for light gauge welding and wholly unsuitable for repair work. The weight of the welding torch used for automobile repair work should be sufficient to insure its standing up under the rather hard usage it gets.

Whether the gases mix in the handle, the head or the tip is of minor importance, provided the torch is properly designed. The construction of the torch is, of course, outside the influence of the user. Since it is a very simple matter to destroy a good torch by improper use, let us see how to take care of the welding torch to get the best out of it.

Care of Welding Torch.—The welding torch is something more than a couple of pieces of tubing terminating in a head. The mixing chamber proportions the two gases and the tip, as a rule, is carefully made to insure an even flow of the mixed gases. Dirt, obstructions of any kind, rough spots, depressions, etc., cause an interruption of this even flow and result in an improperly shaped flame and as well may cause the torch to flash back, that is, the gases, instead of burning at the tip where they properly should, go back to the mixing chamber. To a greater or less extent, the user controls the proper working of the torch provided it has been properly constructed.

Effects of Heat.—At times it is necessary to execute a weld in a corner, a depression or some place where the heat arising from the metal strikes back against the head or tubes of the torch. If at the point where the gases mix, this heat becomes great enough to ignite the gases, a flash-back is the result in most types of torches. When a flash-back occurs, the two gases are burning inside the torch and continue to burn until the oxygen is turned off. The combustion is not perfect, however, and considerable carbon is deposited in the interior of the torch, which makes a desirable condition for a second flash-back. The heat of the flash-back is often sufficient to partially melt some section or to roughen up the walls, and when the torch gets into this condition, continued flash-backs are inevitable. In working in confined areas then, the torch should be frequently cooled by dipping in water, slowly—not plunging the torch quickly.

When the torch is particularly warm, the tips should not be unscrewed or screwed up, but the torch first cooled. The tips should make up by hand freely to the last half turn or so; when they bind and it is necessary to use a wrench to start them on the threads, the threads should be recut. Avoid dirt—keep the torch handle up when not in use and see that the tips are in a rack. Don't shorten the tips by filing—the length of the tip is usually one of some exactness to maintain the proper shape and velocity of the flame. The shut off valves should be kept free and easy working. Repack when necessary, using the same packing material which is usually one of graphic asbestos. If the interior of the torch becomes clogged connect the oxygen hose to the tip and blow the obstruction back through the torch.

Bear in mind that brass or bronze when hot, as a rule, is quite brittle—don't use the welding torch then as a pair of tongs in turning over a cylinder in the fire. If the torch gets the flash-back habit, that is, if it is difficult to keep lighted, or if the velocity of the flame is so great that it is impossible to control the flowing metal in the weld, return it to the manufacturers for repairs. If the torch is not then right, purchase a new one. Good welding is hopeless unless the torch is correctly designed and properly manufactured and it is probably needless to add that all welding torches are not properly manufactured.

Hose and Goggles.—There are a great many varieties of hose used for welding purposes. The choice is largely a matter of personal fancy, but it is to be remembered that size and weight do not necessarily mean strength and that clumsy, heavy hose is not essential.

Preferably the hose should be clamped to the connections on the regulator and torch by a device similar in construction to that used on the hose for water circulation in the automobile motor. If the hose is wired on care should be used not to cut or break the wall and cause a leak. Take care of the hose. Don't allow it to trail on the floor to be tramped upon, to pick up oil, or to be cut or damaged. Replace it when it becomes imperfect. A leaky hose may cause a serious burn or a fire.

To protect the eye from the intensity of the light of the flame, as well as the incandescence of the melting flux, it is necessary to use a darkened glass. For automobile work a simple design is all that is necessary, the lens of a greenish gray color, the depth of which will depend upon the workman. Don't weld without this protection—serious impairment of the vision will result.

This completes the welding equipment. Of course, we need some aids to welding, fluxes, welding rods, a fire of some kind, etc., which we will next take up.

The first chapter of "Automobile Welding," by M. Keith Dunham, is published by permission of the published. The complete book may be had from The Welding Engineer at $1.00.

BUILDING UP WHEELS BY ELECTRIC WELDER

The Springfield Railway Company, of Springfield, Ohio, has been able to prolong materially the life of steel wheels by means of an electric welding outfit.

The company uses a 34-in. steel wheel, and although three turnings are usually obtained, the last one many times is impossible on account of the sharp flanges. In these cases the electric welder is called into play to build up the flanges. This is done, however, after the wheels have been turned, and the new metal applied as the latter is so hard that the machine tool will not touch it. This process requires about six hours' labor, but about 40,000 miles' additional service is obtained in this way.—*Electric Traction.*

DIFFERENT KINDS OF WORKMEN DESCRIBED BY DIRECTOR GENERAL McADOO

Washington, Aug. 6.—In connection with the official announcement of the new wage scale for employees in the mechanical departments of the railroads under Federal control, Director General McAdoo has promulgated a classification of trades that will be of great interest to all manufacturers not only because it is the first attempt at official definition of the duties of skilled workmen but also because of the nation-wide application of the classification and the wage rates thereunder, which will govern national railroad shops in every section of the country. The classification of workers includes the following:

Machinists.—Employees skilled in the laying out, fitting, adjusting, shaping, boring, slotting, milling, and grinding of metals used in building, assembling, maintaining, dismantling, and installing locomotives and engines (operated by steam or other power), pumps, cranes, hoists, elevators, pneumatic and hydraulic tools and machinery, scale building, shafting, and other machinery; ratchet and other skilled drilling and reaming, tool and die making, tool grinding and machine grinding, axle, wheel and tire turning and boring; engine inspecting; air equipment, lubricator and injector work; removing, replacing, grinding, bolting and breaking of all joints on superheaters, oxy-acetylene, thermit and electric welding on work generally recognized as machinists' work; the operation of all machines used in such work including drill presses and bolt threaders using a facing, boring or turning head or milling apparatus, and all other work generally recognized as machinists' work.

Machinist apprentices.—Include regular and helper apprentices in connection with the above work.

Machinist helpers.—Employees assigned to help machinists and apprentices. Operators of all drill presses and bolt threaders not equipped with a facing, boring or turning head or milling apparatus, bolt pointing and centering machines, wheel presses, bolt threaders, nut tappers and facers; cranesmen helpers, toolroom attendants, machinery oilers, box packers and oilers; the applying of couplings between engines and tenders, locomotive tender and draft rigging work, except when performed by carmen.

Boilermakers.—Employees skilled in laying out, cutting apart, building or repairing boilers, tanks and drums, inspecting, patching, riveting, chipping, caulking, flanging and flue work; building, repairing, removing and applying steel cabs and running boards; laying out and fitting up any sheet iron or sheet steel work made of 16 gage or heavier, including fronts and doors; grate and grate rigging, ash pans, front and netting and diaphragm work; engine tender steel underframes and steel tender truck frames, except where other mechanics perform this work removing and applying all staybolts, radials, flexible caps, sleeves, crown bolts, stay rods and braces in boilers, tanks and drums, applying and removing arch pipes; operating punches and shears for shaping and forming, pneumatic staybolt breakers, air rams and hammers; bull, jam and yoke riveters; boilermakers' work in connection with the building and repairing of steam shovels, derricks, booms, housings, circles and coal buggies; I beam, channel iron, angle iron and tee iron work; all drilling, cutting and tapping, and operating rolls in connection with boilermakers' work; oxy-acetylene, thermit and electric welding, on work generally recognized as boilermakers' work; and all other work generally recognized as boilermakers' work.

Blacksmiths.—Employees skilled in welding, forging, shaping, and bending of metal; tool dressing and tempering; spring making, tempering, and repairing; potashing, case and bichloride hardening; flue welding under blacksmith foreman; operating furnaces, bulldozers, forging machines; drop-forging machines, bolt machines and Bradley hammers; hammersmiths, drop hammermen, trimmers, rolling mill operators; operating punches and shears doing shaping and forming in connection with blacksmiths' work; oxy-acetylene, thermit and electric welding on work generally recognized as blacksmiths' work, and all other work generally recognized as blacksmiths' work.

Sheet-metal workers.—Sheet-metal workers shall include tinners, coppersmiths and pipefitters employed in shop yards and buildings and on passenger coaches and engines of all kinds, skilled in the building, erecting, assembling, installing, dismantling and maintaining parts made of sheet copper, brass, tin, zinc, white metal, lead and black planished and pickled iron of less than 16 gage, including brazing, soldering, tinning, leading and babbitting; the bending, fitting, cutting, threading, brazing, connecting and disconnecting of air, water, gas, oil and steam pipes; the operation of babbitt fires and pipe-threading machines; oxy-acetylene, thermit and electric welding on work generally recognized as sheet-metal workers' work, and all other work generally recognized as sheet-metal workers' work.

Molders.—Include molders, cupola tenders, and core makers.

Molder apprentices.—Include regular and helper apprentices in connection with the above.

Molder helpers.—Employees regularly assigned to help molders, cupola tenders, core makers, and their apprentices.

The schedule of rates and method of application adopted by the Director-General for the railroad shops are as follows:

For the above classes of employees (except apprentices and helpers) who have had four or more years' experience and who were on Jan. 1, 1918, receiving less than 55c. per hr., establish basic minimum rate of 55c. per hr., and to this basic minimum rate and all other hourly rates of 55c. per hr. and above, in effect as of Jan. 1, 1918, add 13c. per hr., establishing a minimum rate of 68c. per hr.

The Director-General recognizes that the minimum rates established herein may be exceeded in the case of men of exceptional skill, who are doing special high-grade work, which has heretofore enjoyed a differential. Such cases would include patternmakers, passenger car repair men, oxy-acetylene, thermit, and electric welding in car repair work, etc., and should be presented to the Board of Railroad Wages and Working Conditions for recommendation.

The above classes of employees (except apprentices and helpers) who have had less than four years' experience in the work of their trade will be paid as follows:

One year's experience or less, 50c. per hr.

Over one year and under two years' experience, 53c. per hr.

Over two years' and under three years' experience, 57c. per hr.

Over three years' and under four years' experience, 62c. per hr.

In promulgating this classification and wage schedule, the Director-General makes an urgent appeal to all railroad employees to devote themselves patriotically to the service of the country and thus to justify the substantial increases in compensation and betterment of working conditions provided by the Government.

GAS METERS

Editor:

We should like to know if there is such a thing as an individual meter to attach to an oxygen and acetylene line, to determine the correct costs of gases being used on an operation of any kind. In answering this you probably would say—Why not use the gases in cylinder form? But I will explain my reason for wanting individual meters.

Our welding department has been equipped to manufacture our own acetylene and oxygen, so all welders work from a service line with individual reducing valves for each workman, but at the present we are using the commercial oxygen cylinders which are attached to a cylinder manifold in the gas manufacturing plant, supplying the welders through the service line.

Our idea of the individual meter is to get an accurate statement of the gases each welder uses on a specific operation, which will also give us the difference in gases used by a number of welders working on like operations.—Meters.

Who's Who

C. J. NYQUIST.

C. J. Nyquist, President of the Torchweld Equipment Company, was born in 1870 and has had thirty years of mechanical experience and training. He purchased his first oxy-acetylene apparatus in May, 1905, and since that time had devoted his time and ability to the welding industry. He is 100% American, modest and unassuming and a most valuable member of our rapidly growing industry.

To illustrate his varied and extensive training it might be of interest to add that he is an experienced forge welder and mechanic and has also worked a number of years as an art smith.

C. J. NYQUIST.

He first became interested in the oxy-acetylene process at Liege, Belgium, while visiting the World's Exposition. In 1909 he was Superintendent of the Elyria Pipe and Enamel Co. tank department making welded steel tanks. He then entered the service of the Linde Air Products Co., at Buffalo, and for a year was in charge of demonstrations. His next undertaking was the organization of the Great Lakes Welding Co., at Cleveland, a very successful undertaking and a plant which is one of the best in the country. He disposed of his interest in this company to accept the position of Superintendent of Factory for the Davis-Bournonville Co., at Jersey City, N. J., which position he held in 1911 and 1912. The next four years were spent on the Pacific Coast, two of these as the manager of and a stockholder in the Western Oxygen Co., Los Angeles. Last year he organized the Torchweld Equipment Co.

Mr. Nyquist has made several trips to Europe and has visited the welding schools of Paris, London, Hamburg and Cologne. He has spent much time in the design and construction of equipment and in lecturing and instruction.

Oxy-Acetylene and Electric Welding.

At a recent meeting of the Canadian Railway Club, held at the Windsor Hotel, Montreal, Mr. A. F. Dyer, general foreman, welding department, Grand Trunk Railway, Montreal, read a paper on the subject of "Oxy-Acetylene and Electric Welding and Cutting Processes in Locomotive Works," in the course of which Mr. Dyer stated that the processes have proved themselves fitly to be ranked among the greatest time and labor savers, and also money savers, introduced for a long period. For instance, in the not very distant past, a locomotive with a broken frame was due for a period of several days in the shops before they could strip down one side and remove the frame to the smith's shop, weld it and perhaps have it machined and then replaced. Now we drop the pair of wheels which may cover the break, cut out the crack with the cutting torch to the shape of a double V at an angle of 90 degrees, clean off the oxide caused by cutting and weld up with the metal electrode, using soft steel or Swedish iron. A frame 4 in. or 5 in. being cut and welded in under 14 hours, and it can be done in less time by having two operators on the frame at once, but the men do not like facing each other's arcs, as when they are changing the filling rods their eyes get sore.

Frames, when worn by brake gear and stays, are built up and worn holes are plugged and welded instead of reaming them out to a larger size and thereby weakening the frame. In rebuilding and superheating engines, the same boilers are seldom used on their original frames, and in very few cases do the various holes in angle irons, furnace bearers, etc., come into alignment with frames or boilers; these holes are welded up and redrilled.

The present price of tool steel demands that none shall be wasted, therefore we use it down to the last inch by welding it to tire steel. Twist drills, taps and reamers when broken near the socket end are welded and put into use again. For this purpose we use either the electrode or gas, but in both cases we use vanadium steel filling rods, as we find this gives the best results. Spokes of driving wheels are welded and flat spots on tires have been successfully welded up when it was necessary to do so.

Up to now we have not had much success on cast iron with the iron electrode although with the carbon you can make a fair job, but the gas is unquestionably the best for any of this material. We have successfully welded with the gas, steam shovel engine frames, slides and cylinders by welding in patches of cast iron where worn or broken. When our contract for shells was completed and the lathes that were used for this purpose were being overhauled, it was found that most of the V slide beds were worn down by the tool carriers. These were built up with the gas, which saved machining these beds down in many cases 3/8 in.

In regard to boiler work, most of the welding is done with iron electrode using a mild steel or Swedish iron as a filler, it is found that the electric process localizes the heat more so than the gas, though it is the writer's humble opinion that the gas makes a closer and neater weld, as all welds made by the electrode are more or less porous unless hammered up. It pays better whenever possible to do so to put quarter or half sides in order to get out of the fire line in preference to putting in a patch, for, as a rule, however well the patch is welded it generally gives out in from twelve to eighteen months' service, and the same applies to cracks, whereas the half or quarter side should last as long as the firebox.

When a nest of small cracks is found round the staybolts, the bolts are removed and the holes countersunk and welded up. This method has been found to be very successful.

For cutting steel and wrought iron the oxy-acetylene process has practically no competitor, it being impossible with the carbon point to cut as fast or as fine and neatly as the gas torch, although for scrapping fireboxes and frames, the carbon point is cheaper if time is no object and labor cheap.

No roundhouse should be without an oxy-acetylene outfit, both for repair work and as a part of the wrecking outfit. Many days are lost by engines being tied up through parts having to be sent to the nearest big shops for repair, which could be repaired on the spot with a welding and cutting outfit. All large roundhouses should have both processes, as they would pay for themselves over and over again.

There are many different opinions as to which is the best process; no shop is complete unless it has both equipments, although the gas has really the widest range but, on the other hand, a heavy piece of steel or iron needs no pre-heating with the electrode but welding can be commenced as soon as your arc is drawn. 95 per cent. of the failures which occur instead of being laid on the process should be placed on the shoulders of the operators.

Welding should not be treated as a side line of the machinists' or boilermakers' business, but should be treated as a trade in itself, as it really is, for it needs the entire concentration of a man's mind, careful study, plenty of practice and a conscientious man to make a welder.

Wherever possible a separate building or suitable space should be provided for bench work, and should be equipped with a suitable furnace for heating and annealing castings, and also plenty of floor room to allow of charcoal fires being built for preheating cast iron jobs for welding.

An unusually interesting discussion followed the reading of Mr. Dyer's paper, in the course of which Mr. Barry of the Oxy-Acetylene Company, said that the company's work came from all over the country, from the smaller roads, such as lumber roads, and contractors' outfits, and the like. They ran up against anything and everything and it is interesting to see what they have accomplished when it comes to acetylene and electric welding. Now, if you wish you can weld fireboxes complete with either the acetylene or electric welding. It is quite immaterial which process you use, and of course, the acetylene operator will claim that his process is the best, but he does not know anything about electric welding. Both processes have their advantages, and you can use both. In using the oxy-acetylene process on fireboxes we have tried the butt weld, and the result looks fine, but on account of the chance of the operator being careless the lap weld is best. I beg to differ from Mr. Dyer, as by putting a lap weld in fireboxes, especially in the corners, you can reinforce as heavily as you like, and we have found more success with the lap weld than with the butt weld, but there is no doubt that in welding side sheets to crown sheets or in the corners of fireboxes, either the butt or lap weld can be used. It depends upon the operator. The same thing applies to steel tank work. Many years ago we started in the manufacture of steel tanks, and my experience was that the lap weld was best. You can reinforce it, and make two welds as against one in the butt weld. Electric welding is also applicable to tank work.

Mr. Royer said that he had seen men calling themselves welders, keeping the flame of their blowpipe at one spot and fusing the welding rod in the crack to be welded.

It stands to reason that at one spot the metal was liable to be too hot while the surrounding parts were too cold for proper welding. A good welder should keep his blowpipe moving all the time, so as to distribute the heat evenly at the point he is welding and bringing in fusion at the same time the two edges of the chamber and the added welding rod.

There is no doubt that a considerable amount of boiler work can be done very satisfactorily, if the men are properly trained; however discrimination should be exercised in boiler work, in using only reliable welders in jobs where failure would be dangerous, and apprentices can be used on parts where failure will not produce accident.

Other speakers also strongly favored the use of both oxy-acetylene and electric equipment.—*Railway and Locomotive Engineering.*

FACTORS AFFECTING ARC WELDING.

The arc welding process of repairing broken parts and fabricating new construction has been well known to railway repair shop men for a number of years. All the problems incident to the process, however, have not been solved. They still offer fruitful fields of endeavor for both the chemist and metallurgist. A recent investigation of the welding of mild steel by O. H. Eschholz, of the research engineering department, Westinghouse Electric & Manufacturing Company, has thrown some new light on these problems.

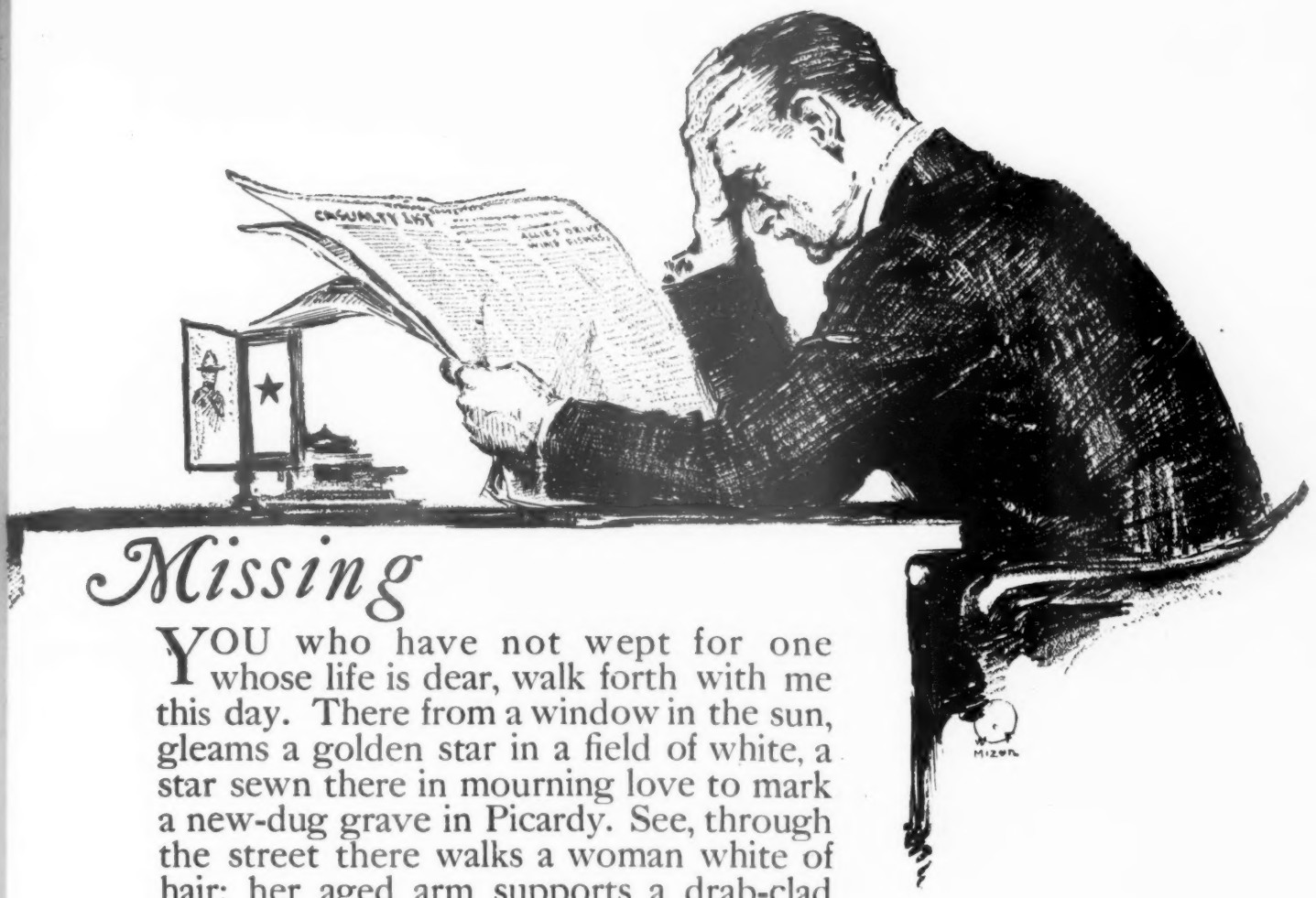
Of the various arc welding processes the one in which a metal rod acts both as electrode and weld filler has the widest use. With this process the filler rod automatically attains the melting temperature and is deposited in a molten state on the hottest section of the weld.

When, in the course of making a weld the metal electrodes are separated, an arc is formed having a highly luminous central core of iron vapor surrounded by a flame of oxides. In order to prevent excessive burning of the iron, the arc must be screened from local air currents as much as possible. This makes it necessary that the welder manipulate the electrode in such a manner that maximum protection by envelopment of the arc is secured. The best way of doing this is by the use of a short arc and the proper inclination of electrodes to compensate for air currents. The use of a short arc also promotes the fusion, concentration and economy of electrode deposit as well as gives it freedom from porosity and reduction in the area affected by heat treatment due to the arc. With long arcs the arc flame cannot be controlled so that it becomes impossible adequately to protect the deposited metal from oxidation. The excessive porosity often found in welds, in the process of making which the arc was broken, is largely due to this cause. In general the action of the atmospheric gases is to refine the vaporized metal. As the field of application of the welding process widens, a method of securing better control of the weld ingredients appears more and more desirable. The use of a refractory tube or asbestos coating has been suggested. However, the difficulty of electrode manipulation is increased thereby to a prohibitive degree and excessive quantities of slag are formed and unavoidably imbedded in the weld. Better possibilities appear to lie in the development of an electrode which generates during operation at atmosphere of permanent gases enveloping the arc.

The fusion obtained at the weld surface and in the body of the filler is determined by the scarf angle, arc current and electrode diameter as well as by arc length. When the abutting sections of the material to be welded are inclined at too sharp an angle, the bottom of the weld is inaccessible and good arc contact is prevented.

The best results are secured when arc currents ranging from 20 amperes for a $\frac{1}{32}$-inch electrode to 200 amperes for a $\frac{1}{8}$-in. electrode are used. Porosity and incomplete fusion often result from welding with too low an arc current. The amount of slag formed and retained by the weld is dependent upon the cleanliness of the electrode and the manipulation of the arc flames to minimize oxidation.

Surface inspection of completed welds is an unsatisfactory check on the weld's characteristics. Observations, or preferably an automatic record of the arc voltage and current and electrode manipulation during welding, permit the formation of a better estimate of the finished product.—*Electric Railway Journal.*



Missing

YOU who have not wept for one whose life is dear, walk forth with me this day. There from a window in the sun, gleams a golden star in a field of white, a star sewn there in mourning love to mark a new-dug grave in Picardy. See, through the street there walks a woman white of hair; her aged arm supports a drab-clad boy, yet in his teens, as with falt'ring step he gropes his sightless way. At an office desk a man, not different from yourself, sits with bowed head and harshly sobs over the day's newspaper where his prescient finger found his son there listed with the "missing." ¶ You who have not wept for one whose life is dear, give utmost thanks that yours have yet been spared to serve the common cause of right. Give utmost thanks that though you may not walk their fields of death and face the peril you fain would share, that of your bloodless treasure you may make an ally that will speed their cause and yours. The day's duty is that you buy War Savings Stamps; that you affix your name on Pershing's Honor Roll as one who has fulfilled his part. So, buy these stamps today.

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War Savings Committee for Illinois, 403 Conway Building

METALLIC ELECTRODE ARC WELDS

Suggestions for Determining the Quality of the Joint—Proper Methods Will Insure Good Results

By O. S. Eschholz
Research Engineer, Westinghouse Electric & Manufacturing Company

THE lack of a satisfactory method for determining the character of welded joints has been responsible, more than any other factor, for the hesitancy encountered amongst the engineering profession towards the extensive adoption of arc welding. To overcome this prejudicial attitude it is eminently desirable to shape our rapidly accumulating knowledge of the operation into an acceptable method of inspection.

Practically all manufactured apparatus is accepted on the basis of compliance with a process specification rigidly enforced, in conjunction with the successful reaction to certain tests applied to the finished product. While it is commonly known that riveting seriously impairs the strength of the joined plates, yet with a proper layout and intelligent inspection the completed structure possesses certain definite characteristics which do not require further verification. The inspector of a finished concrete structure is practically helpless. It is obvious that the weakest sort of construction may be concealed by a sound surface. With a rigid supervision of the process, however, the physical properties of the completed structure can be reliably gaged to the extent that its use is justified even in ship construction. In view of this, it is comforting to realize that electric arc welding is susceptible of even better control than either of these structural operations.

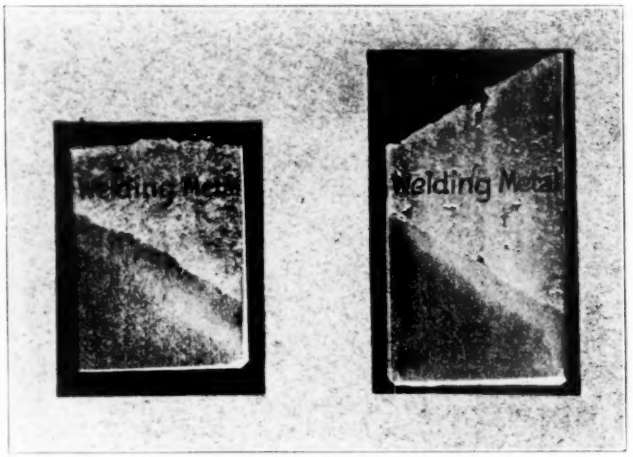

Fig. 2—Good Weld. **Fig. 3—Poor Weld**

HOW TO DETERMINE THE CHARACTER OF THE WELD

The factors which determine the physical characteristics of metallic electrode arc welds are: (1)—Fusion; (2)—Slag content; (3)—Porosity, and (4)—Crystal structure.

Some of the more important methods that have been used or suggested for indicating these characteristics are:

(1) Visual examination of weld to determine:
- (a) Surface finish as an index to workmanship.
- (b) Length of deposits, indicating frequency of breaking arc and, therefore, ability to control arc.
- (c) Uniformity of deposit as an indication of the faithfulness with which filler metal is placed in position.
- (d) Fusion of deposited metal to bottom of weld scarf as shown by appearance of under side of welded joint.
- (e) Predominance of surface porosity and slag.

(2) Chipping edges of deposited layers with cold chisel or calking tool to determine relative adhesion of deposit.

(3) Penetration tests indicating linked unfused zones, slag pockets and porosity by:
- (a) X-ray penetration.
- (b) Rate of gas penetration.
- (c) Rate of liquid penetration.

(4) Electrical tests (as a result of incomplete fusion, slag inclusions and porosity), showing variations in:
- (a) Electrical conductivity.
- (b) Magnetic induction.

The most complete use of these tests would involve their application to each layer of deposited metal as well as to the finished weld. Excepting in rare instances this, however, would not be required by commercial practice in which a prescribed welding process is followed.

Of the above methods the visual examination is of more value than is commonly admitted. In conjunction with it the chipping and calking tests are of particular usefulness. As, however, only a very poor joint will respond to the latter tests, they serve to indicate gross neglect by the operator of cardinal welding principles.

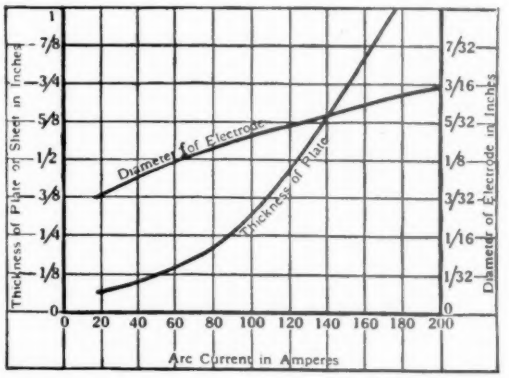

Fig. 4—Chart Showing Approximate Arc Current and Electrode Diameters for Welding Steel Plate of Various Thickness

The penetration tests offer the most reliable indication of the soundness of a weld. Obviously, the presence of unfused oxide surfaces, slag deposits and blow holes will offer a varying degree of penetration. The use of X-rays gives excellent results in the test of small samples, but due to the nature of the apparatus, time required and difficulty of manipulating and interpreting results, it can hardly be considered at the present time applicable to large scale production.

The rate of leakage of hydrogen or air through a joint from pressure above atmospheric to atmospheric, or from atmospheric to partial vacuum can be readily determined. However, the equipment required would be quite cumbersome and the slight advantage over liquid penetration in time reduction is not of sufficient merit to warrant consideration for most welds.

Of the various liquids that may be applied, kerosene has marked advantages due to its availability, low volatility and high surface tension. Because of the latter characteristics, kerosene sprayed on a weld surface is rapidly drawn into any

LINCOLN ARC WELDER

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A typical street railway shop repair job made by a Lincoln Arc Welder.

Sufficient metal is welded onto the top to make good the wear, and the bars were then planed down smooth.

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They are saving street railway companies thousands of dollars yearly in track and shop repairs. They can help you just as readily as they help others.

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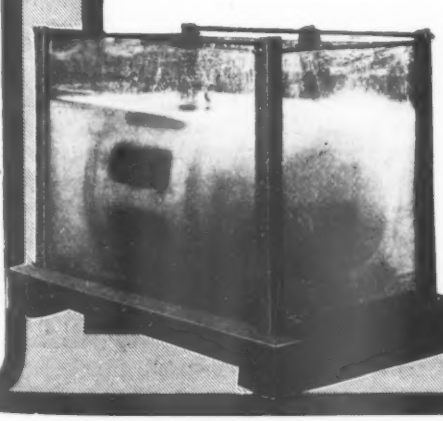

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capillaries produced by incomplete fusion between deposited metal and weld scarf or between succeeding deposits, slag inclusions, gas pockets, etc., penetrating through the weld and showing the existence of an unsatisfactory structure by a stain on the emerging side. On dissolving suitable oil soluble dyes in the kerosene the penetrating liquid will produce a bright red stain. This test is so useful that it has shown the presence of faults that could not be detected with hydraulic pressure or other methods. A sequence of imperfect structures linked through the weld, which presents the greatest hazard in welded joints, will be immediately located by the kerosene penetration. However, it should be born in mind that this method is not applicable to the detection of isolated slag or gas pockets, nor small disconnected unfused areas. Nevertheless it has been shown by numerous tests that a weld may contain a considerable amount of distributed small imperfections without affecting appreciably its characteristics.

If the kerosene test betrays a bad fault it is advisable to burn out the metal with a carbon arc before a rewelding under proper supervision. Large quantities of kerosene are preferably

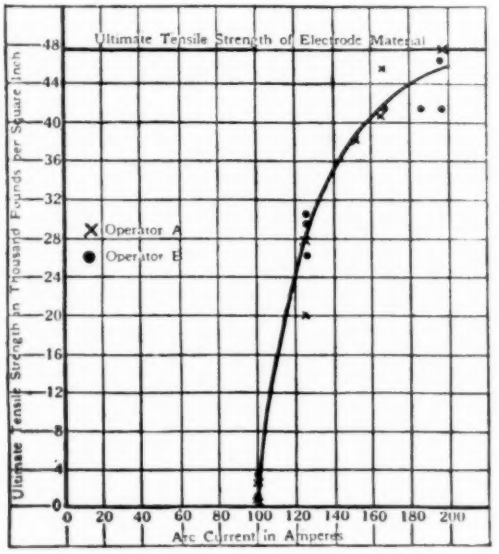

Fig. 5—Variation in Weld Strength With Change in Arc Current

removed by means of sand blast, steam, gasoline CCl_4, etc. No difficulty, however, has been encountered on welding over a thin film of the liquid.

Electrical test methods for determining the homogeneity of welds are still in the evolutionary stage. Such obvious difficulties as elimination of the effect of contact differences, influence of neighboring paths and fields, the lack of practicable, portable instruments of sufficient sensitivity for the detection of slight variations in conductivity or magnetic field intensity are yet to be overcome before their employment is feasible.

No simple tests are available, excepting those which involve subjecting the metal to excessive stresses, for determining the crystal structure. Control of this phase must be determined by the experience obtained from following a prescribed process.

While, therefore, the inspector of metallic arc electrode welds may consider that through the proper use of visual, chipping and penetrating tests a more definite appraisal of the finished joint may be secured than is possible in either riveting or concrete construction, the operation may be still further safeguarded by requiring rigid adherence to a specified process.

Good Results Are Certain If Proper Procedure Is Followed

Haphazard welding can no more produce an acceptable product than hit-or-miss weaving will make a marketable cloth. It is logical that the steps in every manufacturing operation should be controlled to obtain consistently good results. Unfortunately, most welders consider themselves pioneers in an unknown art that requires the exercise of a peculiar temperament for its successful evolution. As a result, welding operators, too numerous to mention, enshroud themselves in the hallowed glow of an expert and encompass their work with a mysterious camouflage bewildering to the untutored. Sometimes, through a series of fortunate coincidences, these "experts" succeed in obtaining a good weld, but more often their "success" is attributable to the friction between slightly fused, plastered deposits.

The process of metallic electrode arc welding, in common with all other operations, is readily susceptible of analysis. Regardless of the metal welded with the arc, the cardinal steps are: (1)—Preparation of weld; (2)—Electrode selection; (3)—Arc current adjustment; (4)—Arc length maintenance; (5)—Filling sequence, and (6)—Heat treatment.

A complete discussion of all of the variations possible in these operations is beyond the scope of this article.*

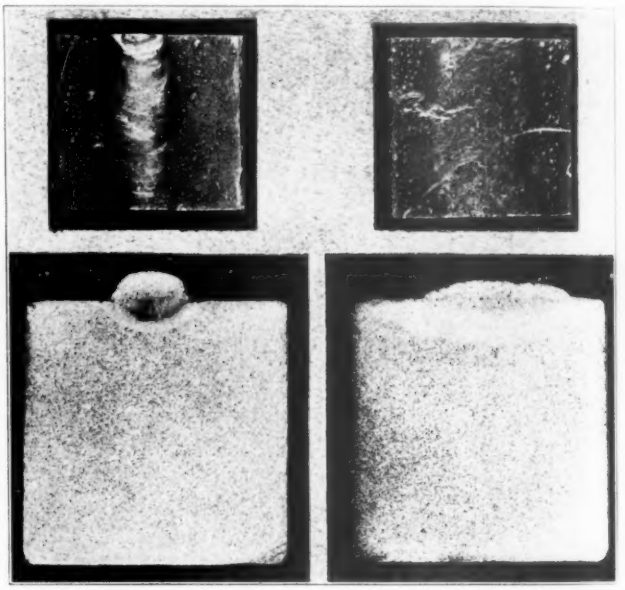

Fig. 6 Fig. 7
Top and Sectional Views of Metal Deposited from Low Carbon Steel Electrode on Steel Stock

The preparation of the weld involves sufficient scarfing and separation of the weld shanks so that the entire surface is accessible to the operator with a minimum amount of filling required. In addition, where necessary to avoid distortion and internal stresses due to unequal expansion and contraction strains, the metal is preheated or placed so as to permit the necessary movement to occur. Various types of scarfs in common use are shown in Fig. 1.

The electrode selection is determined by the mass, thickness and constitution of the material to be welded. An electrode free from impurities and containing about .17 per cent carbon and 5 per cent manganese has been found generally satisfactory for welding low and high carbon, as well as alloy steels. This electrode may also be used for cast iron and malleable iron welding, although more dependable results, having a higher degree of consistency and permitting machining of the welded sections, can be obtained by brazing, using a copper-aluminum-iron alloy electrode with the aid of some simple flux. The brazing of copper and brass with this electrode also gives very successful results. The diameter of the electrode should be chosen with reference to the arc current used.

*1917 Volume, Association of Iron & Steel Electrical Engineers. "Some Recent Investigations in Arc Welding," by O. H. Eschholz.

(Continued on Page 30)

How Much Money Are You Losing Every Day?

Showing the Model A Gas Burning Wiederwax Preheater in use. Two men are working at one time on different castings while other pieces are seen to be heating in the meanwhile.

THE WIEDERWAX PREHEATER

does the preheating work according to the following table which was compiled by a practical welder now using the **Wiederwax Preheater.** Compare your time and costs in preheating with the figures in the table, and then write for the interesting little booklet which tells the story more completely.

The Wiederwax Table of Costs.
This representative table of time and cost in pre-heating is figured on the basis of artificial gas at $1.00 per thousand cubic feet.

Piece	Hours	Cost
Aluminum Crankcases	¾	12c
Automobile Cylinders		
Blocks of 2	½	6c
Blocks of 4	1	12c
Blocks of 6	1	18c
Blocks of 8	1	24c
Radiator Sections	¼	5c
Heater Sections	1	80c
Menlow Heaters (No. 14)	1	48c
Pump Cases (Duplex)	½	8c
Gas and Gasoline Cylinders	½	6c

NOTE: the variation in the cost for equal periods of time is due to the heat needed, in some cases the heat being low in temperature, in others medium, and in still others high.

With Gas at About 30c Per 1000 Cubic Feet in the Natural Gas Territories, These Costs, as Shown in the Above Table, Can Be Cut Approximately 75%.

The *Wiederwax Preheater* is a continuous heating medium giving an even steady heat as intense or as slow as desired. It is controlled at all times by valves which regulate the supply of fuel. All or any part of its heating surface may be used at one time. One, two, three or four men may work upon it at the same time, each doing a job requiring a different degree of heat. The *Wiederwax Preheater* insures perfect expansion, and by means of an asbestos cooling oven does away with the "burying" process and insures perfect contraction. Work requiring $120 worth of charcoal is done by the *Wiederwax Preheater* with $30 worth of gas at the rate of $1.00 per 1000 cubic feet. It eliminates charcoal and makes your shop clean, healthy and safe.

ALUMINUM WELDING

hitherto has been considered extremely impractical, and in the case of aluminum crankcases for aeroplanes, aviators have emphatically refused to use welded cases. Aluminum aeroplane crankcases have been preheated and welded upon the *Wiederwax Preheater* for well known aviators, in each case the weld being perfect and the crankcase as true as it was before being welded.

The Wiederwax Preheater is made in five sizes:
A3660 A3648 A2436 A1824 A1818

GEIST MANUFACTURING COMPANY, Dept. X,
2001 Atlantic Ave., Atlantic City, N. J.

Gentlemen: Kindly send me FREE booklet on Modern Preheating Methods.

Name .....

Street and No. .....

Town or City..... State .....

The Welding Engineer

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VOLUME 3. AUGUST, 1918. NUMBER 8.

The Welder's Pay

ELSEWHERE in this issue we are publishing the Government's official wage scale for employes in the mechanical departments of the railroads. This schedule will be of interest to welders, because for the first time their trade is classified and their rate of pay made uniform. It will be observed that welders are classed under three divisions, Boilermakers, Blacksmiths and Sheet-metal workers, depending upon the work being done. It would appear to us that the welder should be classed separately and alone. As a rule a good welder in a railroad shop is constantly employed at welding. Very few good operators work only a part of the time at welding and if the welder is to work under the jurisdiction of three Unions, confusion may result. The work of the welder, and most particularly the man who works on repairs, and not production work, is varied. Therefore his work is bound to overlap the three trades mentioned.

In commenting on the new classification *The Iron Age* says:

"Why should an operator on a drill press which is equipped with a tool to perform a facing job be classed as a machinist while an operator of a drill press which is equipped with a drill is classed as a machinist's helper? Or by what process of thought does one arrive at a conclusion that cupola tenders and coremakers should be classed as molders? What a compendium of mechanical knowledge must be that man who can decide whether a welding job is "on work generally recognized as machinists' work" or "on work generally recognized as blacksmith's work!"

Many instances like the above can be found in the official announcement of the new wage scale for the mechanical departments of the railroads. But even these cited are not so startling or so far-reaching as the determination that rates are to be based solely upon years of experience, with little regard for the real ability or the output of the workmen or the relative skill and adaptability required to operate various kinds of machine tools. It is true that the award recognizes that there are men of exceptional skill who should have the differential rates that they have previously enjoyed. As a whole, however, the award establishes high general minimums for all the participating classes of workers in all parts of the country."

A Square Deal for the Crippled Soldier.

WHEN the crippled soldier returns from the front, the government will provide for him, in addition to medical care, special training for self-support.

But whether this will really put him back on his feet depends on what the public does to help or hinder, or whether the community morally backs up the national program to put the disabled soldier beyond the need of charity.

In the past, the attitude of the public has been a greater handicap to the cripple than his physical disability. People have assumed him to be helpless, and have, only too often, persuaded him to become so.

For the disabled soldier there has been "hero-worship"; for the civilian cripple there has been a futile kind of sympathy. Both do a man more harm than good.

All the cripple needs is the kind of job he is fitted for, and training in preparation for it. There are hundreds of seriously crippled men now holding down jobs of importance. Other cripples can do likewise, if given the chance.

In the light of results already attained abroad in the training of disabled soldiers, the complete elimination of the dependent cripple has become a constructive and inspiring possibility.

Idleness is the great calamity. Your service to the crippled man, therefore, is to find for him a good busy job, and encourage him to tackle it.

Demand of the cripple that he get back in the work of the world, and you will find him only too ready to do so.

For the cripple who is occupied is, in truth, no longer handicapped.

Can the crippled soldier—or the industrial cripple as well—count on you as a true and sensible friend?

Uncle Sam's Employment Bureau.

ON August 1, the supplying of war industries with common labor was centralized in the U. S. Employment Service of the Department of Labor, and all independent recruiting of common labor by manufacturers having a payroll of more than 100 men will be diverted to the U. S. Employment Service. This is in accordance with the decision of the War Labor Policies Board and approved by the President on June 17. (The War Labor Policies Board is composed of representatives of the War, Navy, and Agricultural Departments, the Shipping Board and the Emergency Fleet Corporation, the War Industries Board, and the Food, Fuel, and Railroad Administrations. Its chairman is Felix Frankfurter, Assistant to the Secretary of Labor.)

The above action was found necessary to overcome a perilous shortage of unskilled labor in war industries. This shortage was aggravated by an almost universal practice of labor stealing and poaching.

While the restrictions against the private employment of labor apply only to common labor at the present time, these restrictions will, as soon as possible, be extended to include skilled labor. In the meantime, recruiting of skilled labor for war production will be subject to federal regulations now being prepared.

This drastic change in the nation's labor program has been found necessary in order to protect the employer and the employed, to conserve the labor supply of the communities and to cut down unnecessary and expensive labor turn-over.

GENERAL WELDING & EQUIPMENT CO.
G.W.&E.C.
107 MASS. AVE. BOSTON, MASS.

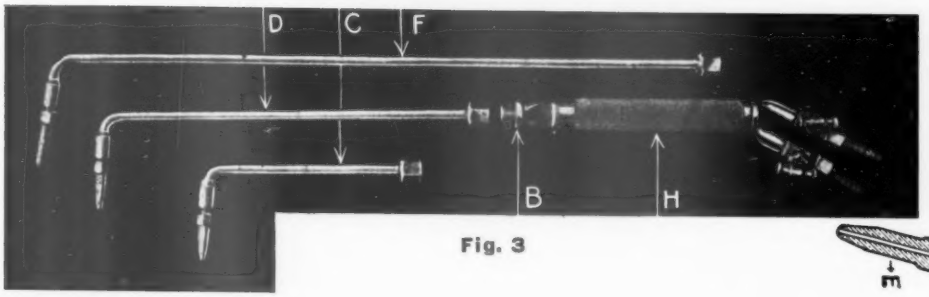


Fig. 3

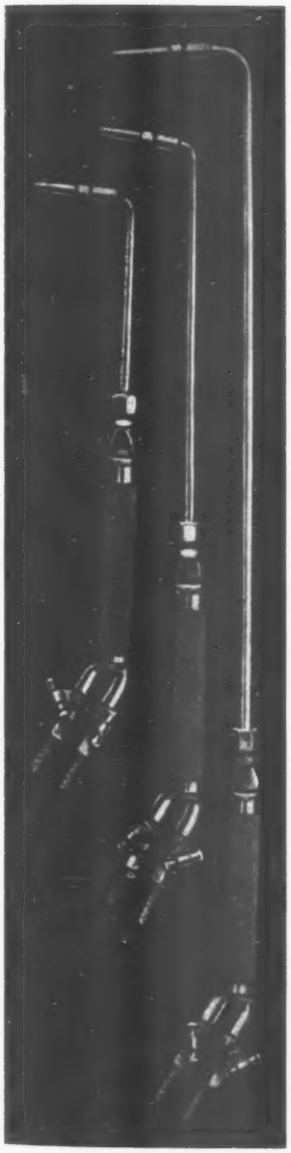


Fig. 2

STANDARD WELDING-TORCH

Description:

Fig. 1 shows the construction of our WELDING TORCHES. The gases are mixed in chamber B, the oxygen coming through the centre hole and the acetylene is sprayed into it through a number of fine holes as shown, thus producing a perfect mixture.

Chamber B is far away from the heat zone and therefore the unmixed acetylene cannot get overheated and flash through overheating and decomposing, neither can it get hot enough to vary in expansion and thus change the mixture of the flame.

If you want to see the difference between a torch mixing in the head and ours mixing far away from the head, try both on a deep, heavy break where all the heat comes back on the torch end. The former will flash every few minutes and ours will work for hours. The gas consumption will be less than half and the weld uniform and strong.

Our Torch is generally sold as a COMBINATION WELDING TORCH, that is a torch base H, with 2 extensions, C and D, so as to have either a 16 in. long torch or a 22 in. long one. In special cases, a still longer extension F, can be supplied to make the torch 30 in. overall. Thus the operator can just connect that extension which is the most suitable for his work.

Picture 2 shows the torch in the 3 different lengths mentioned and picture 3 shows one torch base with its 3 extensions. There is no need of having several torches of different lengths. One torch base with the 2 or 3 extensions would practically give you two or three torches in one. Every length of torch is well balanced, as the principal weight is in the handle and the torch end is so inobstructive that even difficult spots can easily be reached.

Each torch is supplied with a set of 9 tips, able to do all possible work. Every tip can be regulated within wide limits from full heat down to ¼ heat without ceasing to work properly.

EVERY PART OF THE WELDING TORCH IS EASILY ACCESSIBLE AND EXCHANGEABLE. THE WHOLE DESIGN COMBINES OPEN, MODERN CONSTRUCTION, PERFECT WORKMANSHIP AND PRACTICAL EFFICIENCY.

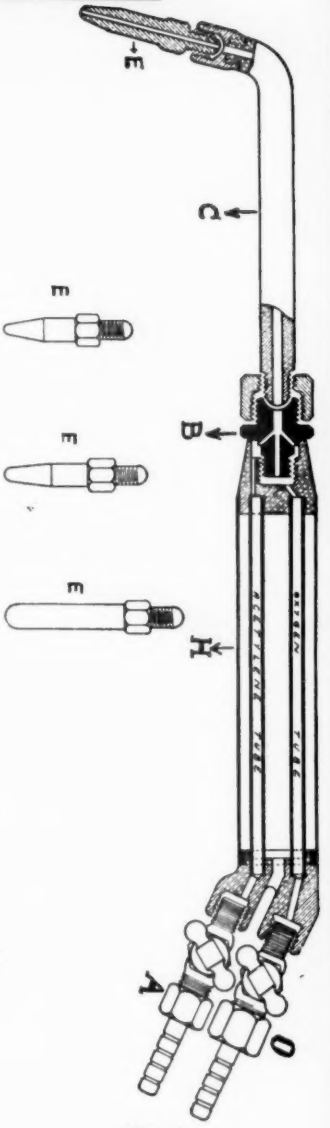


Fig. 1
A—Acetylene Inlet.
O—Oxygen Inlet.
H—Torch Base.
B—Mixing Chamber
C—Extension.
E—Tip.

(which, in some cases, is as high as 100 per cent a week), and to increase the production of essentials.

While non-essential industries will be drawn upon to supply the necessary labor for war work, the withdrawal will be conducted on an equitable basis in order to protect the individual employer as much as possible.

Under the operating methods adopted the country has been divided into thirteen federal districts, each district in charge of a superintendent of the U. S. Employment Service. The States within each district are in turn in charge of a State Director, who has full control of the service within his State.

In each community there is being formed a local community labor board, consisting of a representative of the U. S. Employment Service, a representative of employers and a representative of the employed. This board will have jurisdiction over recruiting and distributing labor in its locality.

A survey of the labor requirements is being made, and in order that each community may be fully protected, rulings have been issued that no labor shall be transported out of any community by the U. S. Employment Service without the approval of the State Director; nor shall any labor be removed by the Service from one state to another without the approval of the U. S. Employment Service at Washington. Every effort will be made to discourage any movements from community to community or state to state by any other service.

This labor program has the approval of all producing Departments of the Government, through the War Labor Policies Board.

It must be understood that farm labor will be protected, for the industrial program distinctly includes special efforts to keep the farmer supplied with labor.

The requirement that unskilled labor must be recruited through the sole agency of the U. S. Employment Service does not at present apply in the following five cases:

1. Labor which is not directly or indirectly solicited.
2. Labor for the railroads.
3. Farm labor—to be recruited in accordance with existing arrangement with Department of Agriculture.
4. Labor for non-war work.
5. Labor for establishments whose maximum force does not exceed one hundred.

When the survey of labor requirements has been made and the aggregate demand for unskilled labor in war work is found, each State will be assigned a quota, representing the common labor to be drawn from among men engaged in non-essential industries in that State.

These State quotas will in turn be distributed among localities. Within each locality, employers in non-war work, including those who are only partially in war work, will be asked to distribute the local quotas from time to time amongst themselves. Quotas by localities and individuals are to be accepted as readily as they are for Liberty Loan and Red Cross campaigns. This plan of labor quotas is a protection for all communities.

The object is to keep any community from being drained of labor, and to use local supply, as far as possible, for local demand. The situation, however, is such that in certain cases some men may have to be transported over long distances.

You will note from the above outline that this is probably the most drastic action that the Government has taken since putting the National Army draft into effect. The absolute necessity for this program can be seen when it is realized that in Pittsburgh, for instance, there are advertisements calling for men to go to Detroit; while in Detroit street cars there are posters asking men to go to Pittsburgh. This same condition is apparent all over the United States and in the consequent shifting of labor a great part of our war effort is dissipated.

WHAT THE WIEDERWAX PREHEATER IS.

"Preheater" of course at once implies some sort of agent which does the work of preparing a piece before welding. Hitherto the accepted method of preheating has been to build a fire of charcoal, charcoal being used in preference to any other fuel because it can be made to give off a fairly even heat. There are, too, a few torches of various kinds, but these are either ineffectual, limited in scope, or adapted only to special kinds of work.

The Wiederwax Preheater is a general, continuous heating medium using for fuel, artificial or natural gas, gasoline or kerosene. One special model built is a combination burner of coal and gasoline.

Though its patents allow it to be built in any special form, the Wiederwax Preheater in general shape is square, standing about thirty inches high, and having a flat top upon which the heating is done.

The top consists of a heavy metal grating between the bars of which is placed a special heat-absorbing element reaching downward to a depth of about six inches. This heating element absorbs the heat furnished by specially constructed burners and distributes it over and through itself until it becomes a cherry red all over, thus giving off the same amount of heat at all points whether at extreme side or in the very center. The burners are placed in rows, each row controlled by its own valve. These rows of burners run from each side toward the center, two-thirds of the way across from the one side, and one-third from the other side. This arrangement makes it possible to use any number of burners, and any part of the heating surface desired either in width or depth.

Immediately beneath the burners are placed a series of two inch pipes with bell like ends turned downward into an oven. These pipes run their open ends out through the sides of the preheater. When they become hot, air is automatically circulated through them, heated, and radiated into the oven directly beneath.

The oven is a roomy, square shaped affair heavily lined with asbestos and is used in cooling the finished jobs. It retains a heat ranging downward from 500 F., according to the number of burners in operation, is free of all draught, and reduces the heat of the welded piece with a slow even contraction, thus removing the danger of warping and cracking.

So it will be readily seen that the Wiederwax Preheater provides the three very important factors which enter into perfect welding. First, it provides a continuous even heat, which insures even expansion. Second, its heat may be controlled by the operator to any degree. In other words a slow even heat may be had at will, or, likewise, an intense, steady heat of high degree. All, or any portion of the heating surface of the machine may be used. Its arrangement of burners controlled by valves makes it possible to heat as many as six pieces at one time, each piece requiring a different degree of heat. This enables the welder to work steadily and uninterruptedly. Third, it provides a perfect medium for cooling, allowing an even contraction, preventing draughts, and obviating practically all danger of cracking or warping, and finally, a method of cooling without trouble or labor, in at least one-third the time required by the burying method.

In a recent issue of The Saturday Evening Post a writer makes the statement that the German army was accompanied into Belgium by 20,000 welders, while at that time there were but 6,000 welders in the United States. Just what authority this statement is based on we do not know, but we doubt if the German army either required or had available any such number of welders. Basing our opinion on the amount of welding equipment manufactured in this country at that time we are inclined to believe that we had more than 6,000 welders.

Get This Torch

It will quickly pay its cost in time and gas saved. Thereafter it will pay you a net profit every day.

It will enable your operators, skilled or unskilled, to turn out better work. It will be worth many times its cost to your business.

You are losing money every day you delay equipping your shop with this money saving, money making tool.

This Is The Lowest Priced High Grade Torch Made **$33.75**

SMITH'S PISTOL GRIP WELDING-TORCH

(For Overhead Work We Make This Torch With a Much Straighter Grip)

One Hand Control. The proportion and volume of gases may be varied instantly, by the hand holding the torch. Lay the torch aside for a minute and the flame is turned out. No gas is wasted. Pick it up, and by the time the torch is over the work it is lighted and the flame adjusted. No time lost even if the work necessitates adjustment of the flame every few seconds. Never need to use two hands on torch, work progresses without stop.

Pistol Grip and Arm Rest relieve operator of fatigue, leaves the wrist in a normal position, and makes the one-hand control entirely practical.

Breech Lock Threads on tips and hose connections require but a quarter turn to remove or to insert them gas tight. Tips can be changed in five seconds. Automatic shut-off valves close the hose lines when detached.

Mixing Chamber in Each Tip insures proper mixture for that size tip. Gives flame proper value at all times. All other torches have but one mixing chamber to accommodate all sizes of tips, which means proper mixture for one size tip only.

Great Gas Economy. Besides the gas saving features mentioned above, this torch will work with acetylene pressure as low as ½ lb. to 1½ lbs.; you can get fully half an hour more work from a cylinder than with other torches.

Sold on Guarantee. Try Smith's Pistol Grip Welding Torch in your shop. If at the end of ten days you are not entirely pleased you may return the torch either to us or the jobber or dealer from whom you bought it and your money will be refunded.

Write for Catalog

We have a high grade proposition for jobbers and dealers

Smith's Inventions, Incorporated, Dept. 1
Minneapolis, Minn.

METALLIC ELECTRODE ARC WELDS

(Continued from Page 22)

The Effect of Too Low Current Values.

It has been almost universal practice to attempt welding with too low an arc current and the result has been a poorly fused deposit. This is attributed largely to the overheating characteristic of most electrode holders, on using correct current value, leading the operator to infer that the current used is excessive.

A section through one-half of an exposed joint welded with the proper current is shown in Fig. 2, while Fig. 3 shows the effect of too low an arc current. The homogeneity and good fusion of the first may be contrasted with the porosity and poor fusion of the latter. (These surfaces have been etched to show the character of the metal and the welded zone.)

Approximate values of arc current to be used for given thickness of mild steel plate as well as the electrode diameter for a given arc current may be taken from the curve, Fig. 4. The variation in strength of 1-inch square welded joints as the welding current is increased is shown in Fig. 5.

While the electrodes now available are giving quite satisfactory results, it is felt that the electrode development is in its infancy and that considerable strides will be made (with its further evolution) in the ductility of welds, consistency in results, as well as in the ease of utilizing the process.

The maintenance of a short arc length is imperative. A nonporous, compact, homogeneous, fused deposit on a 1-inch square bar from a short arc is shown in Fig. 6, while in Fig. 7 is shown a porous, diffused, unfused deposit from a long arc. A skillful operator normally maintains a short arc as the work is thereby expedited, less electrode material wasted and a better weld obtained, due to improved fusion, decreased slag content and porosity. On observing the arc current and arc voltage by meter deflection or from the trace of recording instruments the inspector has a continual record of the most important factors which affect weld strength, ductility, fusion, porosity, etc. It is possible by the use of a fixed series resistance, and an automatic time lag reset switch across the arc to definitely fix both the arc current and the arc voltage, thereby placing these important factors entirely beyond the control of the welder and under the direction of the more competent supervision.

Heat Treatment and Inspection

The method of placing the deposited layers has an important bearing on the internal strains and distortion obtained on contraction. Part of these strains may be relieved by preheating and annealing, as well as by the allowance made in preparation for the movement of the metal.*

In general, heat treatment of a completed weld is not necessary, particularly if it has been preheated for preparation and then subjected to partial annealing. However, in welding even small sections of alloy and high carbon steels a uniform annealing of the structure is desirable if it is to be machined or subjected to vibratory stresses.

In addition to applying the above tests to the completed joint and effectively supervising the process the inspector can readily assure himself of the competency of any operator by the submission of sample welds to ductility and tensile tests or by simply observing the surface exposed on cutting through the fused zone grinding its face and etching with a solution of one part concentrated nitric acid in 10 parts water.

In view of the many resources at the disposal of the welding inspector, it is confidently assumed that this method of obtaining joints will rapidly attain merited recognition as a dependable operation in structural engineering.

The Army Welding School (Ordnance Dept.) formerly operated at Kenosha, Wis., has been moved to Peoria, Ill., and consolidated with the main school at that point. Lieut. Loen Campbell, Jr. is in charge of the school.

*Power, June 26, 1917. "Welds—The Weakness and Merits of Their Structure," by P. A. E. Armstrong.

WELDING TRUCK SIDE FRAMES, BOLSTERS AND ARCH BARS.

The Committee of the M. C. B. Association to whom this subject was assigned were: Messrs. W. O. Thompson, chairman, G. W. Rink, J. J. Hennessey, A. M. McGill, R. W. Schulze, Willard Kells, J. R. Gould, E. H. Sweeley and C. F. Giles.

One of the items brought out in this report was the selection of operations.

First.—Experience has shown that an ordinary helper, handyman or laborer is not possessed of the ability to make proper welds, as they are not conversant with the changes which metals undergo while being welded. A competent mechanic should be selected and given the necessary instruction by an experienced welder before being assigned to this important work. When the desired proficiency has been required, the operator's ability should be certified to by the mechanical officer in charge or by an instructor qualified by experience in general railroad welding with the method involved.

Second.—Only in an emergency should an attempt be made to weld a side frame or bolster until it has been removed from the car, and whenever it is necessary to do so the recommendation should be made by a competent operator or instructor.

Third.—Great care should be exercised to prevent welding under load becoming a general practice for the reason that internal strain is liable to be set up through welding which can be avoided by preheating. Therefore, it is considered good shop practice to preheat cast steel and pressed from bolsters and side frames and this should be done whenever possible.

Fourth.—In making the weld the fracture should be cut or burned out beveled or V-shape in order that a good surface will be obtained for the uniting of the metal, care and patience as well as skill being employed to prevent oxidization. To insure this, the work should be placed at an angle that would allow the flowing out or blowing out of all slag or impurities in the fused metal; the operators giving the torch a rotary movement, will assist in their removal and make a stronger weld than if this practice was not observed.—*Railway and Locomotive Engineering.*

MR. McADOO'S CIRCULAR.

Editor:

Don't you think that it would be a good idea for the welders' organization to let Mr. McAdoo know that we have a trade of our own and are not dependent on other crafts?

I notice in the last circular issued by the Director General in which he outlines the schedule and work pertaining to the different crafts that he gives the welding to each craft in their line of work and makes no provisions for welders.

What are we going to do? Go out and look for other work after spending three or four years learning our own trade and hand the torch over to inexperienced hands to make a failure of the oxy-acetylene or electric welding, as has already been done in many shops in this country?

If the machinist, pipe fitter or any other craft is entitled to our work, why don't they take all other work done as their work?

Why don't they take the blacksmith's work, such as welding frames, brake rods, tools, etc., that belongs to them as much as does the oxy-acetylene or electric welding.

There seems to be a lot of confusion as to who the welding belongs to. Why not give it to welders and draw up a schedule to govern apprentices, helpers, etc., the same as any other craft?

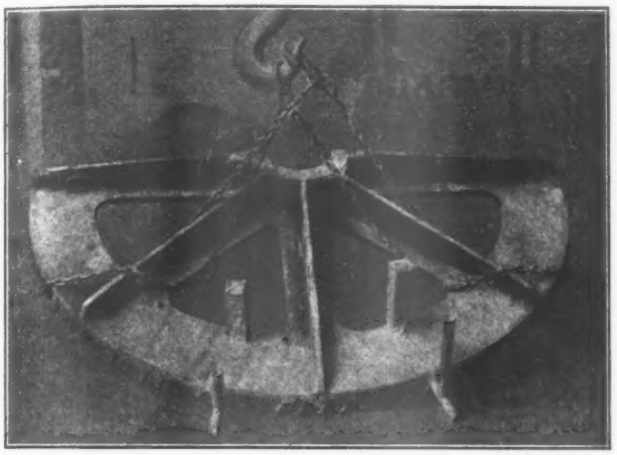
I would like to see this printed in *The Welding Engineer* and hear from some of our brother welders on this matter.

Arthur J. Lardry.

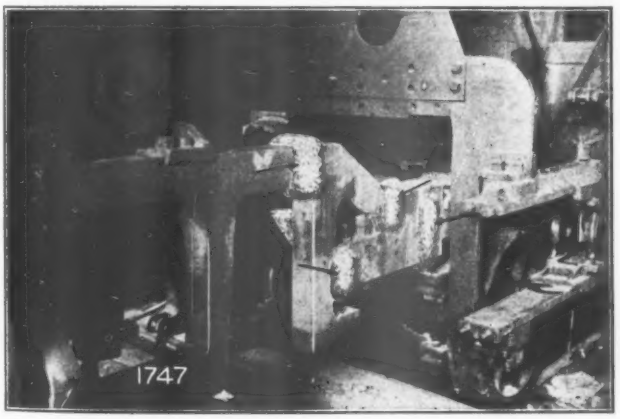
Q. M. C. TRAIN WELDERS.

The Quartermaster Corps of the Army has established a Welding School at Washington, D. C. It is understood 50 students per month will be graduated. The school is in charge of Captain Malone formerly with the Remington Arms Co. at Bridgeport, Conn.

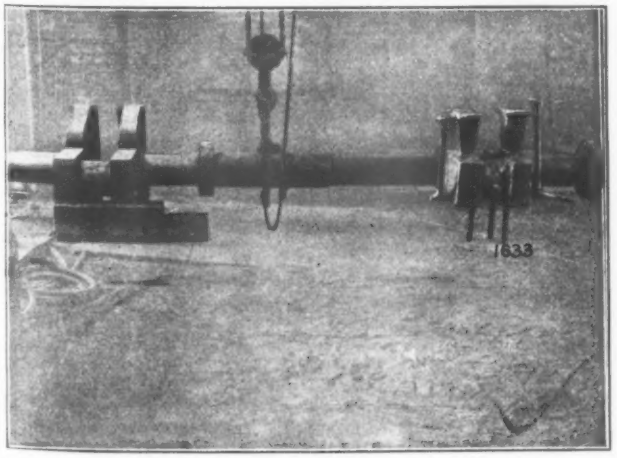
New neck cast on to large roll made with the aid of Thermit and having the boss cast in at the same time.



Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



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COMPARISON OF WELDING SYSTEMS

Essential Factors in Forge-Welding and Their Importance in the Other Processes

By H. James

The old method of welding in a forge fire, where so many variables tend to produce poor work, is being superseded on certain classes of work by the electric and oxy-acetylene processes. Successful forge-welding is dependent on a correct analysis of the material, method of joining the work, fuel, blast pressure, quality of flux and ability of operator. Other important factors are the cost of labor and material. The fuel supplied by the purchasing department is sometimes bought irrespective of analysis. A few analyses will show what is required, and in the case of coal with which the smiths claim that good work cannot be done, it will be noted that the principal difference is in the ash content and the number of British thermal units. Why these slight variations should cause any material difference is hard to explain, but a piece of work unsuccessfully welded in a fire using "bad coal" can be successfully welded in a fire using "good coal." Sulphur is not considered as objectionable in coal today as formerly, but the less there is of it the better. The analyses of smithing coals are given in Table 1.

Test No. 1

Sample	Heat	Appearance	Tensile Strength, Pounds
1	Bright yellow		
2	Bright yellow, plus	Good	30,040
3	Bright yellow	Poor	28,390
4	Very bright yellow	Very good	31,750
5	White	Fair	27,440

The foreman said that the first three samples were not hot enough, but the smith contended that the second sample was. The first, second and fourth samples broke at the weld, but did not pull apart.

Test No. 2

Sample	Heat	Appearance	Tensile Strength, Pounds
A	Bright yellow	Good	26,810
B	Bright yellow	Very good	28,280
C	Bright yellow	Very good	26,920

Table 1. Analyses of Smithing Coal

Brand	Moisture	Volatile Combustible Matter	Volatile Matter	Total Combustile Matter	Fixed Carbon	Ash	Coke	Sulphur	B.T.U.
Logan	0.64	18.18	18.82	91.18	73.00	8.18	81.18	2.82	14,170
Georges Creek	0.30	18.80	19.10	91.95	73.15	7.75	80.09	1.09	14,504
Good Coal	0.34	19.66	20.00	89.21	69.55	10.45	80.00	0.89	14,033
Bad Coal	0.25	18.90	19.15	86.80	67.90	12.95	80.85	1.03	13,404

One of the disadvantages of forge-welding is that regulation of the blast is difficult, and perfect combustion is never realized. Besides, the oxidizing influences that are present tend to produce a poor weld. The flux used is generally borax or sand; but very little is used, and in large shops the welding is done at a high temperature, which results in coarsening the grain. The work is then annealed to restore the grain. If it were not for this high temperature, the welds would be considerably poorer.

That there is considerable variation in the strength of welds is well known. A comparison of results from varied sources shows that the ratio of the strength of welds to the strength of solid pieces, in the case of iron, varies from 60 to 85 per cent, and from 55 to 85 per cent in the case of steel. Chain welding, which is probably the most exact work done, varies from 72 to 95 per cent.

Tests on the safe ending of boiler tubes gives a good idea of the erratic results one may expect to find in practice. The point to be settled in the tests was the feasibility of welding the Parkersburg iron safe ends onto steel tubes supplied by the National Tube Co. In the first test, Parksburg iron safe ends were welded onto Parksburg iron tubes; in the second test, the five iron ends were welded onto National Tube Co.'s steel tubes; and in the third test, steel ends were welded onto the steel tubes. In all cases, the tubes were two inches in diameter and the tensile tests were on eighteen-inch lengths.

D	Bright yellow	Very good	31,440
E	Bright yellow	Fair	23,860

The first four samples broke at the weld, but did not pull out; the fifth broke back on the steel tube about one inch from the weld, at a point where it was overheated.

Test No. 3

Sample	Heat	Appearance	Tensile Strength, Pounds
1	Very bright red	Good	28,220
2	Very bright red	Good	30,980
3	Very bright red	Poor	31,590
4	Very bright red	Poor	25,400
5	Bright yellow	Good	29,450
6	White	Fair	19,280

The first four samples pulled apart at the weld; the fifth and sixth were burned; the last sample broke back on the tube about one inch, where it was overheated.

The labor element is also an important factor in the making of a successful weld. Even in a well organized, up-to-date shop the writer has seen two smiths, working on large work at separate fires, draw the work, knock off the clinker, rush to the hammer a few feet away, and find the hammer boy far down the shop wrestling with a friend. Then after the piece was welded and the men thought a good job was done, they found that the weld practically fell to pieces.

Oxy-acetylene Welding

When welding with acetylene, the analysis of the material is known because this method is generally used on parts that

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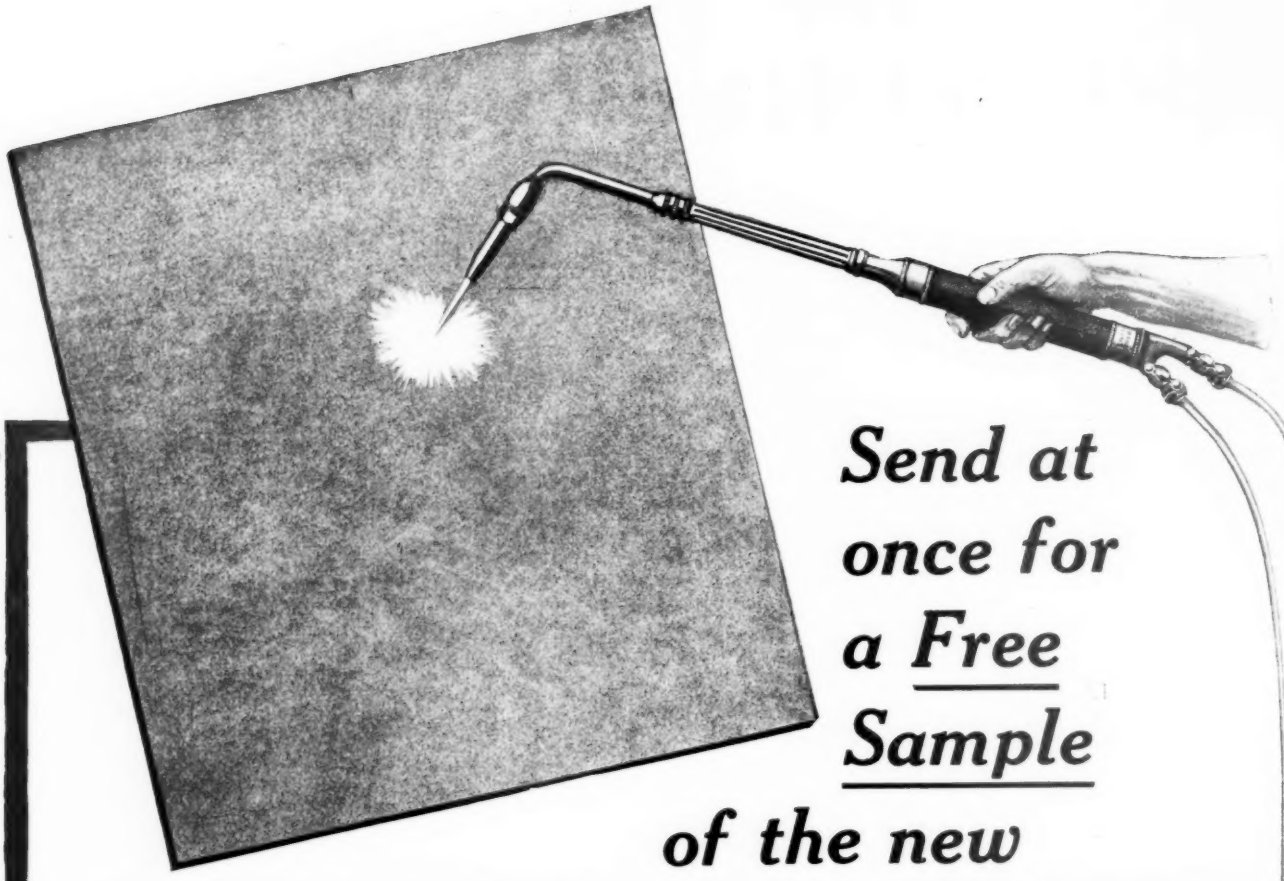

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Table 2. Results Obtained With Electric Welding and Oxy-Acetylene Welding

Method	Breaking Strength, Pounds.	Original Strength of Material, Pounds	Efficiency of Weld, Per Cent	Thickness at Weld Inch	Thickness of Material, Inch	Remarks
Electric	19,420	24,700	78	0.306	0.508	Ground joint
Electric	23,790	24,700	96	0.315	0.513	Ground joint
Electric	25,530	24,700	100	0.324	0.580	Not ground, broke 2½ inches from weld
Electric	24,230	24,700	100	0.317	0.621	Not ground, broke 2½ inches from weld
Electric	24,350	24,700	100	0.322	0.625	Not ground, broke 2½ inches from weld
Oxy-acetylene	17,120	24,590	69	0.305	0.305	Ground joint, broke at weld
Oxy-acetylene	22,690	24,590	92	0.311	0.311	Ground joint, broke at weld
Oxy-acetylene	22,520	24,590	92	0.317	0.418	Not ground, broke at weld
Oxy-acetylene	24,590	24,590	100	0.320	0.463	Not ground, broke 2½ inches from weld
Oxy-acetylene	22,900	24,590	93	0.320	0.359	Not ground, broke at weld
Oxy-acetylene	19,900	24,580	81	0.328	0.415	Not ground, broke through weld
Oxy-acetylene	21,520	24,580	88	0.317	0.390	Not ground, broke through weld
Oxy-acetylene	19,610	24,580	80	0.312	0.420	Not ground, broke through weld
Oxy-acetylene	23,890	24,580	97	0.318	0.385	Not ground, broke through weld
Oxy-acetylene	22,410	24,590	91	0.334	0.415	Not ground, broke through weld
Oxy-acetylene	13,590	21,500	63	0.279	0.337	Not ground, broke through weld

have failed in service. Generally, also, the quality is determined; in any case, the difference between iron and steel is not so noticeable. The material used to make the weld is purchased in the correct form and to the right analysis. The blast pressure is registered by a gage, so that there is less danger of oxidation, and the quantity of acetylene is regulated. A flux is nearly always used, though its composition may vary considerably, as is here shown:

Analyses of Fluxes

	Per Cent
Borax	57.35 to 33.79
Calcium carbonate	6.47 to 38.16
Siliceous matter	33.03 to 1.06
Carbon	3.15 to 26.99

In acetylene or electric welding, the operator generally does little else, whereas a smith may do several other kinds of work, and the old saying that practice makes perfect holds good. An intelligent handy-man is generally employed, and his wages are a trifle less than a smith's. The cost of material, which includes gas, is greater, however, than when the welding is done in the forge fire. The cost of welding molecular rearrangement due to the graphite change. A ¼-inch square bar tested on 24-inch centers had a strength of 3,250 pounds before welding and 3,000 pounds afterward. In another test, the strength of the bar was 3,350 pounds before welding and 3,200 pounds afterward. The welding sticks were high in silicon, about 3 per cent, and the outside was thoroughly cleaned so that no sand or dirt could get into the weld and cause trouble in subsequent machining.

The whole of an intricate piece of material should be preheated before welding, so that any internal strains that may exist will be relieved. This preheating and annealing should, of course, be gradual and the parts treated should be kept away from drafts. It is evident that the nearer a piece can be brought to the welding heat in this treatment the less will be the local expansion, proportionately, and therefore the less will be the strains set up. Preheating or annealing is accomplished by an oil torch or oven, neither of which is as expensive as acetylene gas.

The chief difference in the cost of oxy-acetylene welding and forge-welding appears to be the adaptability of the oxy-acetylene process to the work and the fact that in many cases stripping of a machine is unnecessary. A smith may not be available, but an acetylene apparatus is.

Table 4. Thermit Welds

found.

	Tensile Strength, Pounds per Square Inch	Percentage of Reduction in Area	Percentage of Elongation in 2 Inches
Fracture coarsely crystalline	50,750	2.60	Not measured
Fracture coarsely crystalline	58,480	4.92	Not measured
Fracture coarsely crystalline	56,800	3.00	2.67
Fracture coarsely crystalline	61,800	.....	1.00
Fracture coarsely crystalline	61,000	9.00	5.00

Table 3.—Comparison of Oxy-Hydrogen, Oxy-Acetylene, and Electric Processes.

Process and Treatment	Breaking Strain, Pounds per Square Inch	Percentage of Elongation	Percentage of Reduction of Area
Oxy-hydrogen, original plate, ¼ inch thick	68,400	20.0	.....
Oxy-hydrogen, welded	32,300	3.0	.....
Oxy-hydrogen, welded	29,800	5.0	.....
Oxy-hydrogen, welded and annealed	31,000	3.0	.....
Oxy-hydrogen, welded and annealed	41,300	4.5	.....
Oxy-acetylene, original plate	68,400	20.0	.....
Oxy-acetylene, welded	59,450	7.0	.....
Oxy-acetylene, welded	53,390	12.0	.....
Oxy-acetylene, welded and annealed	56,900	14.0	.....
Oxy-acetylene, original plate	49,100	33.4	64.00
Oxy-acetylene, welded with steel plate	46,900	9.0	.....
Oxy-acetylene, welded with iron wire	48,600	13.5	9.40
Oxy-acetylene, cold-rolled shafting, original bar[1]	73,740	19.0	50.99
Oxy-acetylene, welded	36,590	1.5	8.12
Oxy-acetylene, Norway iron, original bar[1]	45,000	43.0[2]	66.42
Oxy-acetylene, Norway iron, welded	36,900	6.5[2]	3.91
Electric weld, original plate	61,150	22.0	.....
Electric weld, welded	44,000	6.0	.....
Electric weld, welded	37,680	4.0	.....
Electric weld, welded and annealed	36,400	.....	.....

[1]All bars machined to original area. [2]Elongation in two inches.

Electric and Thermit Welding

Locomotive flue welding is now done extensively by the electric process. A comparison of costs shows that the electric method is cheaper than the acetylene. But as far as putting the tubes in is concerned, both are dearer than setting them by hand. But the service conditions give a greater mileage for the welded tubes. The approximate cost by beading is 7.3 cents per flue; by oxy-acetylene welding, 9.8 cents; by electric welding, 7.7 cents.

Firebox sheets are welded and patched successfully by the electric process without removing the sheets. Taking out the sheets or removing a locomotive frame is costly in time and money. Frames have been welded in place by blacksmiths, but is a difficult job; the better method is to employ thermit. Thermit has also been used successfully for welding side rods. Ordinarily, when welding a channeled

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rod the flutes are filled with iron, which is allowed to project over the edges of the break. Holes are sometimes drilled a few inches from the ends of the break; when welding, these holes serve to rivet the work together. The rods, after welding, are annealed but are not refluted, being left solid. In Table 4 are given the results obtained by thermit welding. All the test-pieces were cut from risers. The coarse fracture indicates that this steel could be improved by annealing.

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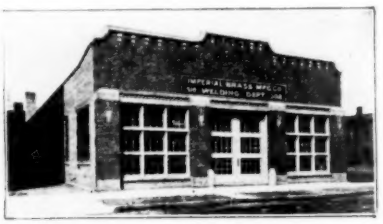

This welding shop is one of the finest and most thoroughly equipped in the country, and maintains a staff of expert welders who are in a position to help manufacturers to make prompt deliveries, keep up production, and reduce manufacturing costs. The Oxy-Acetylene Welding process, used in this shop, is far superior to riveting, in making metal joints.

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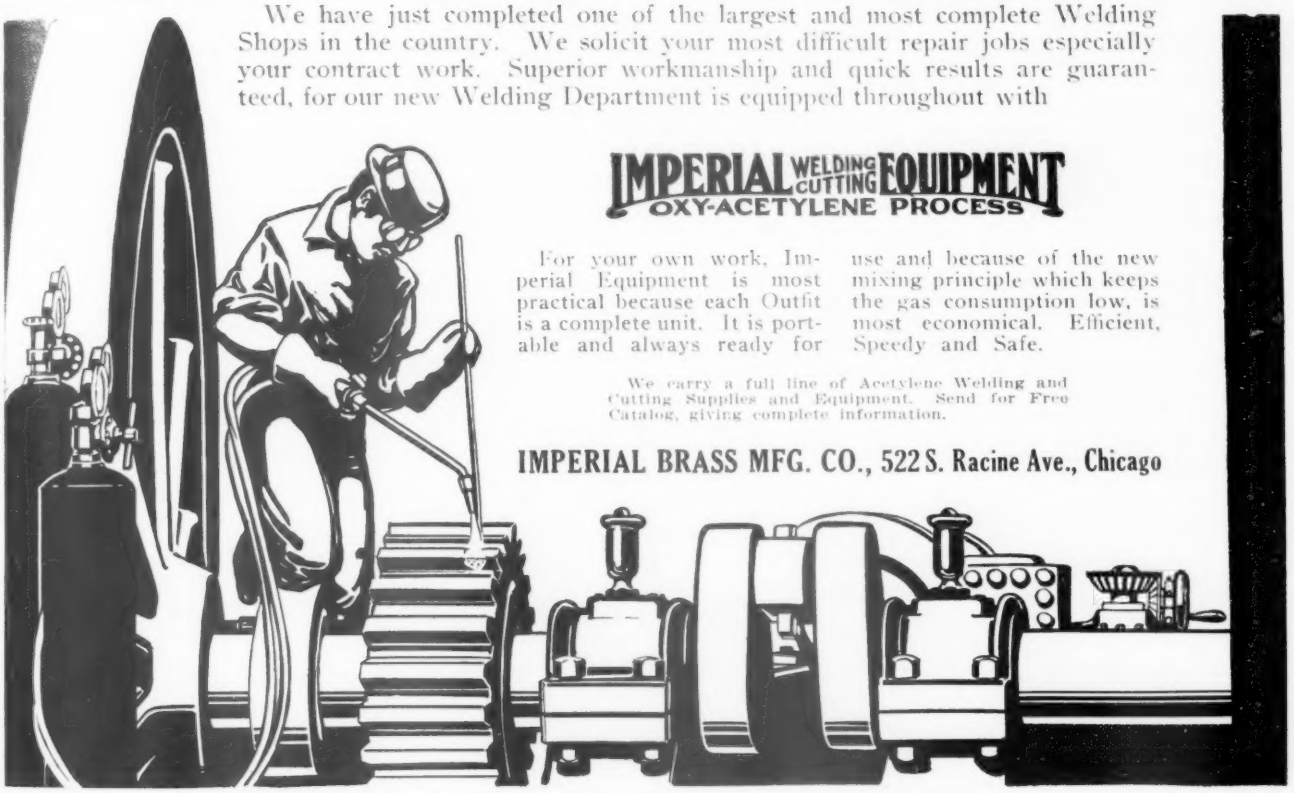

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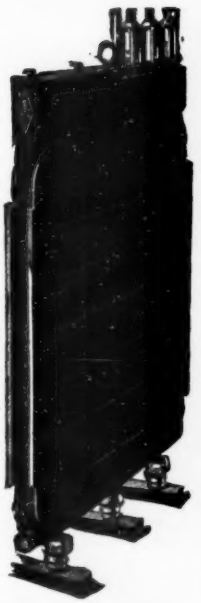

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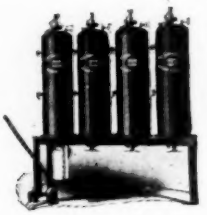

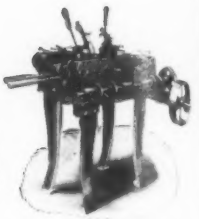

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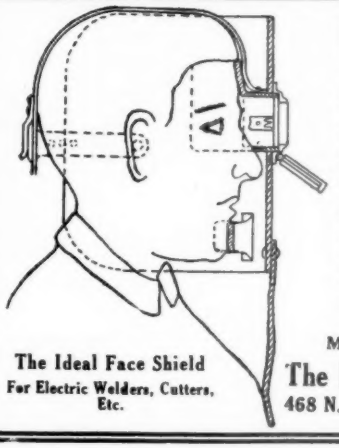

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